HAMADRYAD
Vol. 27. No. 2. August, 2003
Date of issue: 31 August, 2003
ISSN 0972-205X

CONTENTS

OVERVIEW

NOTES

BOOK REVIEWS

Hamadryad Vol. 27, No. 2, pp. 165 – 174, 2003.

PRELIMINARY CHECKLISTS OF THE HERPETOFAUNA OF THE ANAMBAS AND NATUNA ISLANDS (SOUTH CHINA SEA)

Tzi Ming Leong[1], L. Lee Grismer[2] and Mumpuni[3]

[1]Department of Biological Sciences, National University of Singapore, Kent Ridge, Singapore 119260.
Email: scip0132@nus.edu.sg
[2]Department of Biology, La Sierra University, 4700 Pierce Street, Riverside, CA 92515-8247, USA.
Email: lgrismer@lasierra.edu
[3]Herpetology Department, Division of Zoology, Research and Development Centre for Biology,
Indonesian Institute of Sciences, Gedung Widyasatwaloka, Jalan Raya Jakarta km. 46, Cibinong,
Bogor 11961, Indonesia. Email: mzb@indo.net.id

(with three text figures)

ABSTRACT.– **From reviews of literature and museum specimens, a comprehensive checklist of the reptilian and amphibian fauna was compiled for the South China Sea island groups of the Anambas and Natunas. As of present, 23 reptiles and seven amphibians have been recorded from the Anambas, while 63 reptiles and 27 amphibians were recorded from the Natunas. The photographs in life of two anurans endemic to the island of Pulau Natuna Besar (*Leptobrachella natunae* and *Kalophrynus bunguranus*) are here presented for the first time.**

KEYWORDS.– **Herpetofauna, Anambas, Natunas, Bunguran, South China Sea, island, biogeography.**

INTRODUCTION

The present day offshore islands of the South China Sea are of biogeographic importance because they serve as 'stepping stones' within the Sunda Shelf (Whitten et al., 1987). Of particular significance are the emergent islands that lie between the east coast of the Malay Peninsula and the west coast of Borneo. This chain of islands comprises (from west to east) the Seribuat Archipelago (including Pulau Tioman), the Anambas Archipelago, the Natuna Archipelago and the Tembelan Archipelago. It has been clearly shown that when sea levels were at 120 m BPL (below present-day level) (ca. 17, 000 yrs BP-before present), all of these island groups were contiguous with the exposed Sunda Shelf (Voris, 2000: Fig. 1a). The north Natuna and south Natuna islands were already separated by the Great Sunda River, which flowed northeast in between the two island groups (Whitten et al., 1987). About 11, 000 yrs BP (sea levels 50 m BPL), the north Natuna and Anambas islands were the first to be isolated (Voris, 2000: Fig. 1d), while south Natuna, Tembelan and Tioman were still a part of the exposed Sunda Shelf. South Natuna and Tembelan were subsequently isolated when sea levels rose to 30 m BPL, while Tioman was only clearly isolated at 20 m BPL (Voris, 2000: Figs. 1f and g). The Anambas Archipelago (Fig. 1b; 03°00' N, 106°00' E) consists of the two main islands of Pulau Siantan (03° 10' N; 106° 15' E) in the north and Pulau Jemaja (Letong) (02°55' N; 105°45' E) in the south. The Natuna Archipelago (Fig. 1c) consists of the larger Pulau Natuna Besar (Bunguran) (04° 00' N; 108° 15' E) in the north and Pulau Serasan (Sirhassen) (02° 30' N; 109° 03' E) to the south.

As most of these South China Sea islands are endowed with significant forest cover, are topographically heterogeneous, and have experienced varying durations of isolation; they would serve as refugia for a wide variety of Sundaic flora and fauna, and even become cradles for speciation. Zoological results from early collections in the Anambas and Natunas have focused

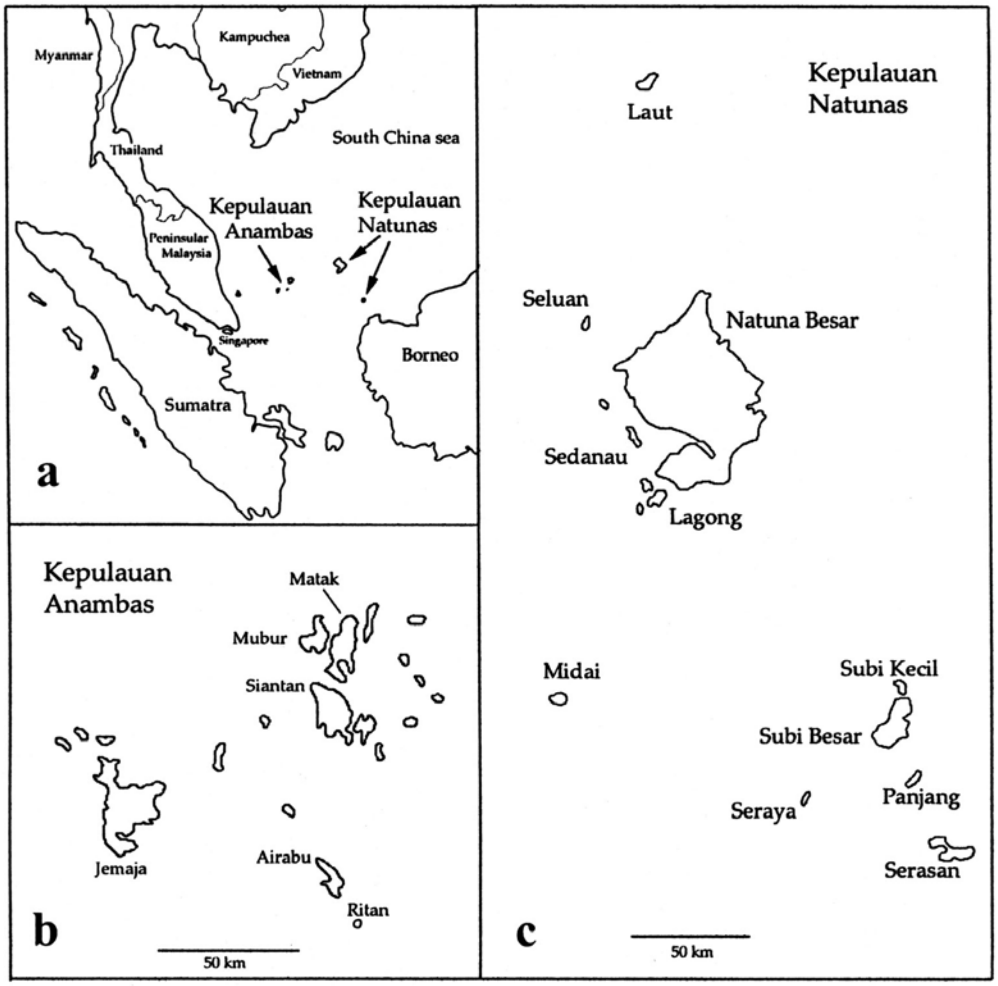

FIGURE 1a-c: Schematic maps of Kepulauan Anambas (b) and Kepulauan Natunas (c) in the South China Sea (Kepulauan = Archipelago). Maps prepared by L. Lee Grismer.

on the avifauna (Chasen and Kloss, 1928; Chasen, 1934; Oberholser, 1917, 1932), mammals (Chasen, 1935) and dragonflies (Laidlaw, 1932a and b). In terms of herpetofaunal diversity, Pulau Tioman has been the most thoroughly documented by far (Lim and Lim, 1999; Grismer et al., 2002), while the Natunas and Anambas pale in comparison. Only a handful of amphibians and reptiles have been recorded from the Anambas, whereas the Natunas collections seem to be more complete. Virtually nothing is known from the Tembelans. Hence, a compilation of the amphibian and reptile species previously known from the islands of Anambas and Natunas would serve as an initial platform for subsequent forays into these little explored archipelagos.

MATERIALS AND METHODS

In addition to compiling data from various herpetological references, historical voucher specimens from two main collections were examined [Zoological Reference Collection (ZRC), of the Raffles Museum of Biodiversity Research (RMBR), National University of Singapore; and the United States National Museum (USNM), Smithsonian Institution]. For the Anambas islands, the only references were by Smedley (1928) and three snakes listed by de

FIGURE 2: Gravid adult female *Leptobrachella natunae* (Günther, 1895) from Pulau Natuna Besar (SVL 21.7 mm).

FIGURE 3: Adult *Kalophrynus bunguranus* (Günther, 1895) from Pulau Natuna Besar (SVL 26.0 mm).

TABLE 1: Preliminary list of the herpetofauna of the Anambas Islands. A total of 23 reptile and seven amphibian species were recorded. (hc = human commensal; nB = non-Bornean).

No.	Species	Island/s	ZRC, USNM, MZB vouchers/References
	REPTILIA		
	Order Sauria		
	F. Agamidae		
1.	*Acanthosaura armata* (nB)	Siantan	ZRC.2.311; Smedley, 1928
2.	*Aphaniotis fusca*	Siantan	USNM 26546
3.	*Bronchocela cristatella*	Letong, Jemaja, Siantan, Matak	ZRC.2.381-383, 502-503; USNM 26578; Smedley, 1928
4.	*Draco melanopogon*	Siantan	USNM 26545
5.	*Draco sumatranus*	Letong, Jemaja; Siantan	ZRC.2.743-747; Smedley, 1928
	F. Gekkonidae		
6.	*Cnemaspis* cf. *kendallii*	Siantan	ZRC.2.1109-1110; USNM 26547-26549; Smedley, 1928
7.	*Gehyra mutilata* (hc)	Padang, Jemaja	ZRC.2.1458; Smedley, 1928
8.	*Gekko gecko* (hc)	Jemaja	ZRC.2.1013; Smedley, 1928
9.	*Gekko monarchus* (hc)	Siantan	ZRC.2.1092
10.	*Hemidactylus frenatus* (hc)	Siantan	Smedley, 1928
	F. Scincidae		
11.	*Dasia olivacea*	Letong, Jemaja	ZRC.2.1600; Smedley, 1928
12.	*Emoia atrocostata*	Mubur	USNM 26519
13.	*Lipinia quadrivittata*	Siantan	Smedley, 1928
14.	*Mabuya multifasciata* (hc)	Siantan, Matak, Rittan	ZRC.2.1780-1783; USNM 26579-82, 28113-16; Smedley, 1928
	F. Varanidae		
15.	*Varanus nebulosus* (nB)	Siantan	ZRC.2.1888-1889; Smedley, 1928
16.	*Varanus salvator*	Jemaja, Pingi, Siantan	ZRC.2.1906; Smedley, 1928
	Order Serpentes		
	F. Colubridae		
17.	*Ahaetulla prasina*	Jemaja, Siantan	ZRC.2.3663, 4117, 4120, 4134, 4140; Smedley, 1928; De Haas, 1950
18.	*Elaphe flavolineata*	Anambas	USNM 26515
19.	*Rhabdophis chrysargos*	Siantan	ZRC.2.4219; Smedley, 1928; De Haas, 1950
	F. Crotalidae		
20.	*Trimeresurus puniceus* (nB)	Siantan	USNM 26544
	F. Elapidae		
21.	*Ophiophagus hannah*	Siantan	T. M. Leong (pers. obs., 1996)
	F. Pythonidae		
22.	*Python reticulatus*	Siantan	USNM 26543; Smedley, 1928; De Haas, 1950
	Order Testudines		
	F. Trionychidae		
23.	*Amyda cartilaginea*	Siantan	T. M. Leong (pers. obs., 1996)
	AMPHIBIA		
	Order Gymnophiona		
	F. Ichthyophiidae		
24.	*Ichthyophis* sp.	Jemaja	ZRC.1.9441

	Order Anura		
	F. Bufonidae		
25.	*Bufo melanostictus* (hc)	Siantan	ZRC.1.90-97; Smedley, 1928
	F. Ranidae		
26.	*Limnonectes blythii*	Jemaja, Siantan	ZRC.1.9433-9434, 9444; MZB
27.	*Limnonectes kuhlii*	Jemaja	ZRC.1.9435; MZB
28.	*Rana chalconota*	Jemaja, Siantan	ZRC.1.9437-9440, 9442, 9443; MZB
29.	*Phrynoglossus laevis*	P. Bajau	ZRC.1.9453
	F. Rhacophoridae		
30.	*Polypedates leucomystax* (hc)	Siantan	ZRC.1.1021-1061, 3435; Smedley, 1928

Haas (1950). Other Anambas records were from ZRC and USNM vouchers. For the Natuna islands, early records were listed by Günther (1895 – collections of A. H. Everett and C. Hose), Van Kampen (1923) and Smedley (1931a, b), with subsequent additions by Inger (1966) and Dring (1983). Reptile records were compiled by de Rooij (1915, 1917) and De Haas (1950). ZRC vouchers from the Natunas were collected as far back as 1911, while others were collected in 1928 and 1931. The USNM vouchers were largely collected by William L. Abbott in 1900. Recent (March/Nov 2002) joint ASEAN expeditions to both archipelagos consisted of a small terrestrial/freshwater survey team, which resulted in moderate additions to both checklists. Representative vouchers of these species have been deposited at Balitbang Zoologi, Puslitbang Biologi – LIPI [formerly Museum Zoologicum Bogoriense (MZB)].

RESULTS AND DISCUSSION

The results of this compilation are reflected in Tables 1 and 2, for the Anambas and Natuna islands respectively. In total, only seven amphibians and 23 reptiles were recorded for the Anambas, while 27 amphibians and 63 reptiles were recorded for the Natunas. Despite these modest figures, the actual herpetofaunal biodiversity in these islands must be far greater. It is interesting to note that a handful of non-Bornean species (denoted by ‘nB’ in both Tables) are known to occur in these two island groups. The occurrence of such species (e.g., *Ptychozoon lionotum*, *Varanus nebulosus* and *Trimeresurus puniceus*) in the Natunas represent an easternmost extent of their geographical distribution in the Sundas. The occurrence of *Acanthosaura armata* in the Anambas (not yet known from Natunas) also marks its easternmost distribution. Conversely, Bornean species (denoted by ‘B’ in Table 2) have been recorded from the Natunas (not recorded for Anambas). These species (*Phoxophrys nigrilabris*, *Bufo divergens* and *Leptobrachella serasanae*) serve to illustrate the past physical connections via land bridges to the Borneo landmass. Thus far, merely two species, *Leptobrachella natunae* (Günther, 1895) and *Kalophrynus bunguranus* (Günther, 1895), may be considered island endemics (found only on Pulau Natuna Besar). Although an exquisite colour lithograph of *K. bunguranus* (then known as *Diplopelma bunguranum*) was published a year after its discovery (Günther, 1896), photographs (in life) of both Natuna-endemic frogs are presented here for the first time (Figs. 2 and 3, respectively). Endemics remain to be discovered from the Anambas.

Another observable trend between the herpetofauna of both island groups is the presence of human commensal species (denoted by ‘hc’ in both Tables), such as the common house geckoes (e.g., *Gehyra mutilata* and *Gekko monarchus*), the agamid *Calotes versicolor*, the skink *Mabuya multifasciata*, the toad *Bufo melanostictus* and tree frog *Polypedates leucomystax*. All these are indicators of a relatively long history of human settlement and invasion. However, further conversion of original habitats is still being carried out. Hopefully, if the terrestrial/riparian habitats on these islands are preserved, we may obtain a more complete picture of their amphibian and reptile inhabitants with subsequent surveys.

TABLE 2: Preliminary list of the herpetofauna of the Natuna Islands. Natuna Besar, or Bunguran, is denoted by the abbreviation NB. Where a specific island was not stated, NI (Natuna Islands) is indicated. A total of 63 reptile and 27 amphibian species were recorded. (hc = human commensal; En = island endemic; B = otherwise only known from Borneo; nB = non-Bornean; nPM = not known from Peninsular Malaysia). * Regarded by Inger (1966) as synonymous with *R. baramica*, but being revalidated as a distinct species (Leong et al., in press). Both species were sympatric in swamp forests, as is also the case in Singapore.

No.	Species	Island/s	ZRC, USNM, MZB, BMNH vouchers/References
	REPTILIA		
	Order Sauria		
	F. Agamidae		
1.	*Aphaniotis fusca*	NB, Lingung, Serasan	ZRC.2.331-332, 5542; USNM 28146, 28125; MZB; Günther, 1895; De Rooij, 1915; Smedley, 1931a
2.	*Bronchocela cristatella*	NB, Sadanau, P. Soebi Kecil (south), Midai	ZRC.2.384, 504-505, 521-522; USNM 28122-23; MZB; Günther, 1895; De Rooij, 1915; Smedley, 1931a, b
3.	*Calotes versicolor* (hc)	NB	ZRC.2.5541; MZB
4.	*Draco cornutus* (nPM)	NB	ZRC.2.521-522; Smedley, 1931a
5.	*Draco fimbriatus*	NB	USNM 28133; Günther, 1895; De Rooij, 1915; Smedley, 1931a
6.	*Draco maximus*	NB, P. Laut	Günther, 1895; De Rooij, 1915
7.	*Draco melanopogon*	NB	ZRC.2.643; Günther, 1895; De Rooij, 1915; Smedley, 1931a
8.	*Draco obscurus*	NB	Smedley, 1931a; ZRC.2.519-520
9.	*Draco quinquefasciatus*	Lingung	USNM 28144
10.	*Draco sumatranus*	P. Laut, P. Panjang, Serasan	USNM 28141; Günther, 1895; De Rooij, 1915; Smedley, 1931b
11.	*Gonocephalus chamaeleontinus*	NB, P. Laut	Günther, 1895; De Rooij, 1915
12.	*Gonocephalus liogaster*	NB, P. Laut	ZRC.2.5544; USNM 28124, 28126, 28137; MZB; Günther, 1895; Dring, 1979; Manthey & Denzer, 1992
13.	*Phoxophrys nigrilabris* (B)	NI, Serasen	Günther, 1895; De Rooij, 1915
	F. Gekkonidae		
14.	*Cnemaspis* cf. *kendallii*	NB, Lingung, Serasan	ZRC.2.1111-1113, 5546; USNM 28145, 28149; Günther, 1895; De Rooij, 1915
15.	*Cnemaspis* cf. *nigridia*	NB	ZRC.2.5547-5550; MZB
16.	*Cyrtodactylus* cf. *consobrinus*	NB	ZRC.2.5551; MZB
17.	*Gehyra mutilata* (hc)	Serasan	ZRC.2.1226; Smedley, 1931b
18.	*Gekko gecko* (hc)	P. Soebi Kechil	ZRC.2.1014; Smedley, 1931b
19.	*Gekko monarchus* (hc)	Serasan	ZRC.2.1489-1490
20.	*Gekko smithii*	Serasan	ZRC.2.1488; Smedley, 1931b
21.	*Hemidactylus frenatus* (hc)	NB, P. Panjang	ZRC.2.5405, 5540; MZB
22.	*Ptychozoon kuhli*	P. Berian	ZRC.2.1472; Smedley, 1931b
23.	*Ptychozoon lionotum* (nB)	NB	USNM 28138
	F. Lacertidae		
24.	*Takydromus sexlineatus*	NI, NB	ZRC.2.5558, 5561; MZB; Günther, 1895; De Rooij, 1915
	F. Scincidae		
25.	*Dasia olivacea*	NI, Serasan	ZRC.2.1601; Günther, 1895; De Rooij, 1915; Smedley, 1931b
26.	*Emoia atrocostata*	Serasan, Seraya	ZRC.2.1562-1563; USNM 28121; Smedley, 1931b

27.	*Mabuya multifasciata* (hc)	NB, Serasan, P. Panjang, Laut, Lingung, Midai	ZRC.2.1784-1792; USNM 28117-20, 28187-91; Günther, 1895; De Rooij, 1915; Smedley, 1931a, b
28.	*Mabuya rugifera*	Lingung	USNM 28147
	F. Varanidae		
29.	*Varanus nebulosus* (nB)	P. Medi	ZRC.2.1884-1887
30.	*Varanus salvator*	Serasan	USNM 28104
	Order Serpentes		
	F. Colubridae		
31.	*Ahaetulla fasciolata*	NB, Midai	USNM 28109; De Rooij, 1917; De Haas,1950
32.	*Ahaetulla prasina*	NB, Panjang, Serasan, Laut	ZRC.2.4146, 4148; USNM 28107; De Rooij, 1917; Günther, 1895; Smedley, 1931b; De Haas, 1950
33.	*Aplopeltura boa*	Serasan	ZRC.2.2731; Smedley, 1931b; De Haas, 1950
34.	*Boiga dendrophila*	Serasan	USNM 28106
35.	*Boiga drapiezii*	NB	ZRC.2.4198; Smedley, 1931a; De Haas, 1950
36.	*Calamaria lumbricoidea*	NI, NB	Günther, 1895; De Rooij, 1917; De Haas, 1950; Inger & Marx, 1965
37.	*Cerberus rynchops*	NB, Serasan	ZRC.2.4398, 4401, 5560; Smedley, 1931b; De Haas, 1950
38.	*Chrysopelea paradisi*	NB	De Haas, 1950
39.	*Chrysopelea pelias*	NI, NB	De Rooij, 1917; De Haas, 1950
40.	*Dendrelaphis caudolineatus*	NB, P. Berian, Serasan	ZRC.2.3828, 3831; De Rooij, 1917; Smedley, 1931b; De Haas, 1950
41.	*Dendrelaphis pictus*	NB	ZRC.2.5559; USNM 29443; Günther, 1895; De Rooij, 1917; De Haas, 1950
42.	*Dryocalamus tristrigatus* (nPM)	NB	Günther, 1895; De Rooij, 1917; De Haas, 1950
43.	*Dryophiops rubescens*	Serasan	Günther, 1895; De Rooij, 1917; De Haas, 1950
44.	*Gongylosoma baliodeirum*	NB	Günther, 1895; De Rooij, 1917; De Haas, 1950
45.	*Gonyosoma oxycephalum*	NB	Günther, 1895; De Rooij, 1917; De Haas, 1950
46.	*Homalopsis buccata*	NB	T. M. Leong & C. P. Lim (pers. obs., 2002)
47.	*Macropisthodon rhodomelas*	NB	USNM 28112
48.	*Oligodon purpurascens*	NB	USNM 29442
49.	*Pareas laevis*	Serasan	Günther, 1895; De Rooij, 1917; De Haas, 1950
50.	*Psammodynastes pulverulentus*	NB	Günther, 1895; De Rooij, 1917; De Haas, 1950
51.	*Ptyas fusca*	NB	Günther, 1895; De Rooij, 1917; De Haas, 1950
52.	*Rhabdophis conspicillatus*	NB	USNM 28111; Günther, 1895; De Rooij, 1917; De Haas, 1950
53.	*Sibynophis geminatus* (nB, nPM)	NB	USNM 29442
54.	*Xenochrophis maculatus*	NI	De Rooij, 1917; De Haas, 1950
	F. Crotalidae		
55.	*Trimeresurus puniceus* (nB)	NB, P. Laut	Günther, 1895; De Rooij, 1917; De Haas, 1950
56.	*Tropidolaemus wagleri*	NB, P. Panjang	ZRC.2.2981-2982; Günther, 1895; De Rooij, 1917; Smedley, 1931b; De Haas, 1950
	F. Cylindrophiidae		
57.	*Cylindrophis ruffus*	NB	USNM 28110
	F. Pythonidae		
58.	*Python reticulatus*	NI	Günther, 1895; De Rooij, 1917; De Haas, 1950
	F. Xenopeltidae		
59.	*Xenopeltis unicolor*	NB	ZRC.2.5585

	Order Testudines		
	F. Bataguridae		
60.	*Cuora amboinensis*	NB, Serasan	USNM 28173-74, 28177-79; Günther, 1895; De Rooij, 1915
61.	*Cyclemys dentata*	NB	Günther, 1895; De Rooij, 1915
62.	*Heosemys spinosa*	NB	USNM 28175-76, 28180; Günther, 1895; De Rooij, 1915
	F. Trionychidae		
63.	*Dogania subplana*	NB	ZRC.2.009; Günther, 1895; De Rooij, 1915; Smedley, 1931a
	AMPHIBIA		
	Order Anura		
	F. Bufonidae		
64.	*Bufo asper*	NB	ZRC.1.10140
65.	*Bufo divergens* (B)	NB	ZRC.1.10068; Günther, 1895; Van Kampen, 1923; Inger, 1966
66.	*Bufo melanostictus* (hc)	NB, Serasan	ZRC.1.89; Günther, 1895; Van Kampen, 1923; Smedley, 1931b
67.	*Bufo quadriporcatus*	NB	T. M. Leong (pers. obs., 2002); Günther, 1895; Van Kampen, 1923
68.	*Pelophryne brevipes*	NB	Inger, 1966
69.	*Pelophryne guentheri* (B)	Serasen	Günther, 1895
	F. Megophryidae		
70.	*Leptobrachella natunae* (En)	NB	ZRC.1.10102; MZB; Günther, 1895; Van Kampen, 1923; Types: BMNH 1947.2.25.15, 17, 18 (Dring, 1983)
71.	*Leptobrachella serasanae* (B)	Serasan	Type: BMNH 1947.2.25.16 (Dring, 1983)
72.	*Leptobrachium* sp.	NB	ZRC.1.9447-9451; MZB
73.	*Megophrys nasuta*	NI, NB	ZRC.1.10100; MZB; Van Kampen, 1923
	F. Microhylidae		
74.	*Kalophrynus bunguranus* (En)	NB	ZRC.1.10070; Types: BMNH 1947.2.11.38-41 (Iskandar & Colijn, 2000); Günther, 1895, 1896
75.	*Kalophrynus pleurostigma*	P. Laut	Günther, 1895
	F. Ranidae		
76.	*Fejervarya limnocharis* (hc)	NB	ZRC.1.10124; MZB; Günther, 1895; van Kampen, 1923
77.	*Limnonectes blythii*	NB, Serasan	ZRC.1.397-408, 10069; MZB; Günther, 1895; Smedley, 1931b
78.	*Limnonectes hascheanus* (nB)	NB	T. M. Leong (pers. obs., 2002); Günther, 1895; Van Kampen, 1923
79.	*Limnonectes kuhlii*	Serasan	ZRC.1.673-678; Smedley, 1931b
80.	*Limnonectes paramacrodon*	NB	ZRC.1.10129
81.	*Phrynoglossus laevis*	NB	ZRC.1.10141; MZB
82.	*Rana baramica*	NB	T. M. Leong (pers. obs., 2002)
83.	*Rana chalconota*	NB, Serasan	ZRC.1.552, 9452; Smedley, 1931b
84.	*Rana erythraea* (hc)	NB, Serasan, P. Laut	ZRC.1.600-606, 10113; Günther, 1895; Van Kampen, 1923; Smedley, 1931b; Inger, 1966
85.	*Rana glandulosa*	NB	ZRC.1.613; Smedley, 1931a
86.	*Rana laterimaculata* *	NB	T. M. Leong (pers. obs., 2002)
	F. Rhacophoridae		
87.	*Philautus ?petersi*	NB	ZRC.1.10110-10112; MZB; Günther, 1895; Van Kampen, 1923
88.	*Polypedates colletti*	NB	Günther, 1895; Inger, 1966

89.	*Polypedates leucomystax* (hc)	NB, P. Panjang	ZRC.1.9454, 10117; MZB; Günther, 1895; van Kampen, 1923
90.	*Polypedates macrotis*	NB, Serasan	ZRC.1.1012; Günther, 1895; Smedley, 1931b; Inger, 1966

ACKNOWLEDGEMENTS

We are grateful to Harold K. Voris (Division of Amphibians and Reptiles, Department of Zoology, Field Museum of Natural History, Chicago) for his insightful paper on south-east Asian biogeography. We also thank Peter K. L. Ng and Kelvin K. P. Lim (ZRC, RMBR, National University of Singapore) for granting access to relevant literature and specimens. Daisy Wowor (LIPI Pusat Penelitian dan Pengembangan Biologi, Indonesia/Systematics and Ecology Lab, Department of Biological Sciences, NUS), Darren C. J. Yeo (RMBR), Cheng Puay Lim (NUS) provided unforgettable field companionship to the first author. Ronald I. Crombie of the Smithsonian Institution (USNM) kindly assisted with providing catalogue numbers and loan of specimens. Aaron M. Bauer provided useful and valuable comments, which improved the manuscript.

LITERATURE CITED

CHASEN, F. N. 1934. Nine new races of Natuna birds. *Bull. Raffles Mus.* (9): 92-97.

________1935. On a collection of mammals from the Natuna Islands, South China Sea. *Bull. Raffles Mus.* (10): 5-42.

________& C. B. KLOSS. 1928. On a collection of birds from the Anamba Islands, South China Sea. *J. Malayan Br. Royal Asiatic Soc.* 6(3): 43-63.

DE HAAS, C. P. J. 1950. Checklist of the snakes of the Indo-Australian Archipelago (Reptiles, Ophidia). *Treubia* 20 (3): 511-625.

DE ROOIJ, N. 1915. The reptiles of the Indo-Australian Archipelago. Part I: Lacertilia, Chelonia, Emydosauria. E. J. Brill, Leiden. xiv + 384 pp.

________1917. The reptiles of the Indo-Australian Archipelago. Part II: Ophidia. E. J. Brill, Leiden. xiv + 334 pp.

DRING, J. C. M. 1979. Amphibians and reptiles from northern Trengganu, Malaysia, with descriptions of two new geckoes: *Cnemaspis* and *Cyrtodactylus*. *Bull. British Mus. nat. Hist.* (*Zool.*) 34(5): 181-241.

________1983. Frogs of the genus *Leptobrachella* (Pelobatidae). *Amphibia-Reptilia*, 4: 89-102.

GRISMER, L. L., J. A. McGUIRE, R. A. SOSA & H. KAISER. 2002. Revised checklist and comments on the terrestrial herpetofauna of Pulau Tioman, Peninsular Malaysia. *Herpetol. Rev.* 33(1): 26-29.

GÜNTHER, A. 1895. The reptiles and batrachians of the Natuna Islands. *Nov. Zool.*, *London*, 2: 499-502.

________1896. *Diplopelma bunguranum* (colour lithograph). *Nov. Zool.*, *London*, 3: Pl. 8, Figs. 2-3.

INGER, R. F. 1966. The systematics and zoogeography of the Amphibia of Borneo. *Fieldiana (Zool.)* 52: 1-402.

________& H. MARX. 1965. The systematics and evolution of the oriental colubrid snakes of the genus *Calamaria*. *Fieldiana (Zool.)* 49: 1-304.

ISKANDAR, D. T. & E. COLIJN. 2000. Preliminary checklist of southeast Asian and New Guinean herpetofauna. Part I: Amphibians. *Treubia* 31(3): 1-134.

LAIDLAW, F. F. 1932a. A list of dragonflies (Odonata) collected from the Anamba Islands, South China Sea. *Bull. Raffles Mus.* (7): 99-100.

________1932b. Odonata from the South Natuna Islands, South China Sea. *Bull. Raffles Mus.* (7): 100-101.

LEONG, T.-M., M. MATSUI, H.-S. YONG & A. A. HAMID. In press. Revalidation of *Rana laterimaculata* Barbour & Noble, 1916 from synonymy of *Rana baramica* Boettger, 1901. *Current Herpetol*.

LIM, K. K. P. & L. J. LIM. 1999. The terrestrial herpetofauna of Pulau Tioman, Peninsular Malaysia. *Raffles Bull. Zool.* Supplement No. 6: 131-155.

MANTHEY, U. & W. DENZER. 1992. Die Echten Winkelkopfagamen der Gattung *Gonocephalus* Kaup (Sauria: Agamidae) V. Die *bellii*-Gruppe. *Sauria*, *Berlin* 14(3): 7-20.

OBERHOLSER, H. C. 1917. The birds of the Anamba Islands. *U. S. Nat. Mus. Bull.* 98: vi + 75 pp, 2 pls.

________1932. The birds of the Natuna Islands. *U. S. Nat. Mus. Bull.* 159: vi + 137 pp.

SMEDLEY, N. 1928. Some reptiles and Amphibia from the Anamba Islands. *J. Malayan Br. Royal Asiatic Soc.* 6(3): 76-77.

________1931a. On some reptiles and a frog from the Natuna Islands. *Bull. Raffles Mus.* (5): 46-48.

________1931b. Amphibians and reptiles from the South Natuna Islands. *Bull. Raffles Mus.* (6): 102-104.

VAN KAMPEN, P. N. 1923. The Amphibia of the Indo-Australian Archipelago. E. J. Brill, Leiden. xii + 304 pp.

VORIS, H. K. 2000. Maps of Pleistocene sea levels in southeast Asia: shorelines, river systems and time durations. *J. Biogeogr.* 27: 153-1167.

WHITTEN, A. J., S. J. DAMANIK, J. ANWAR & N. HISYAM. 1987. The ecology of Sumatra. 2nd Edition. Gadjah Mada University Press, Yogyakarta. xx + 583 pp.

Received: 10 December 2002.
Accepted: 24 January 2003.

Hamadryad Vol. 27, No. 2, pp. 175 – 178, 2003.

THE TADPOLE OF *RANA MIOPUS* BOULENGER, 1918 FROM PENINSULAR MALAYSIA

Tzi-Ming Leong[1] and Chuan-Fong Lim[2]

Department of Biological Sciences, National University of Singapore, Kent Ridge, Singapore 119260.
Email: [1]scip0132@nus.edu.sg; [2]birdwing@pacific.net.sg
(with two text-figures)

ABSTRACT.– The diagnostic larva of *Rana miopus* Boulenger, 1918, is described here for the first time based on a developmental series from Johor, southern Peninsular Malaysia. Its microhabitat consists of stagnant pools of water on the forest floor. The tadpole of this species may be positively identified by (i) diagonal, dark brown stripes on dorsum, (ii) dark brown reticulation/spots on flanks, anterior of venter and tail, (iii) presence of pineal spot, (iv) presence of numerous dermal glandules over entire body and (v) Labial Tooth Row Formula 2(2)/3(1).

KEYWORDS.– Peninsular Malaysia, Ranidae, *Rana miopus*, Anura, larva, tadpole.

INTRODUCTION

Rana miopus was described by Boulenger (1918) based on a specimen collected by Malcolm A. Smith from Nakhon Si Thammarat (Nakon Sitamarat), Thailand, and initially identified as *R. humeralis* Boulenger, 1887 (type locality: Bhamo, Myanmar, formerly Burma). It differed from *R. humeralis* in terms of its relatively shorter limbs, reduced toe webbing, finger proportions, more oblique loreal region and narrower interorbital distance (Boulenger, 1918; 1920). Attention should be brought to two instances of inconsistencies with regards to the type locality of this species. In Smith (1930: 106), it was incorrectly reported that *R. miopus* was "originally discovered at Kwala Aring in Kelantan, this frog has since been obtained in the Nakon Sritamarat mountains …". In Frost (1985: 505), its type locality is listed as "Khao Wang Hip, Nakhon Si Thammarat [Thailand]", but "Khao Wang Hip" should be omitted as it refers to a separate locality from which Smith had recorded *R. humeralis* (Boulenger, 1918).

In Thailand, the species has yet to be found elsewhere, other than the type locality (Taylor, 1962). In Peninsular Malaysia, it has been recorded from the states of Terengganu, Kelantan, Perak and Pahang (Bourret, 1941; Grandison, 1972; Berry, 1975; Leong, 2000). The voucher specimens of both adult and larval *R. miopus* from Johor to be discussed and described here actually represent a new state record and a southerly extension of its occurrence in the Peninsula. These were collected by the second author from around ditches and forest pools beside Sungai Emas, a tributary of Sungai Endau, on 11 November, 1974, amidst disturbed primary lowland rainforest. However, it was only recently (January, 2003) that these specimens were brought to the attention of the first author, who verified the identities of the preserved larvae. Other species of anuran larvae found from the same and adjacent pools include *Polypedates* sp. (ZRC.1.1848-1972), *Rhacophorus* sp. (ZRC.1.1973-1977) and *Fejervarya limnocharis* (ZRC.1.1978-2027). Prior to this formal description, the diagnostic tadpole of *R. miopus* was unknown (Leong, 2002).

MATERIALS AND METHODS

Representative voucher specimens of adults and larvae are deposited at the Raffles Museum of Biodiversity Research Zoological Reference Collection [Adult males (ZRC.1.1487-1488; SVL: 64.1-65.8 mm, exhibiting humeral glands, nuptial pads on first finger, and vocal sacs); Larvae (ZRC.1.2822-2871; n = 49, Stages 26-42)]. Larvae were fixed in a 1:1 solution of

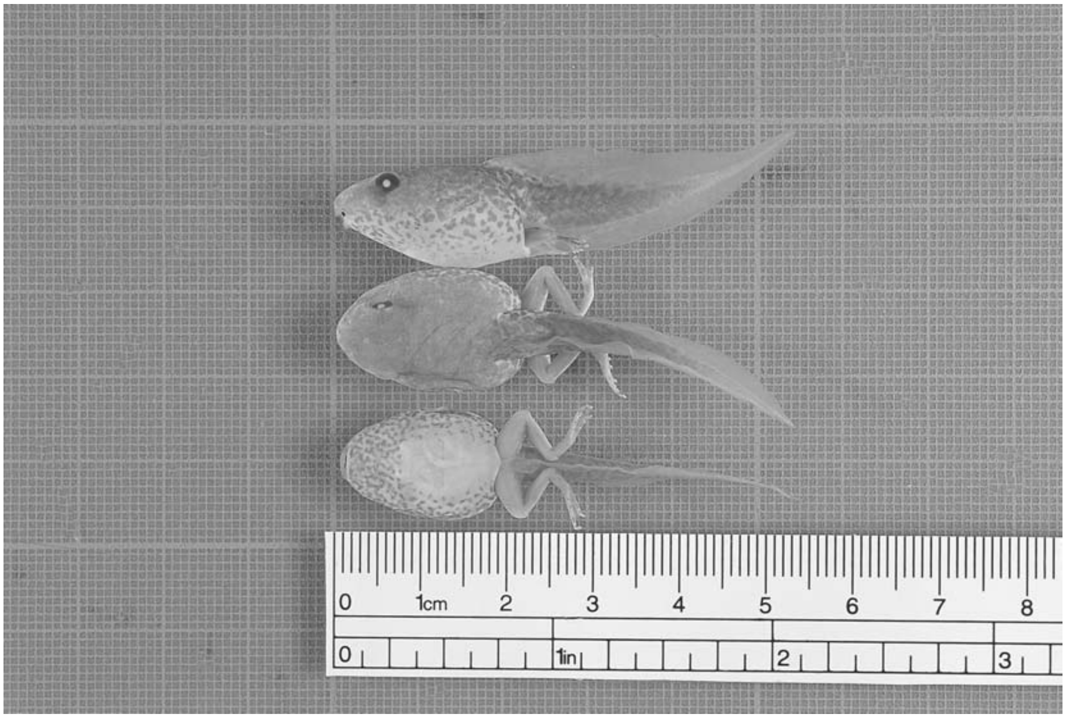

FIGURE 1: Lateral, dorsal and ventral views of larval *Rana miopus* (Gosner stage 40). Note diagonal stripes on dorsum and mottled anterior of underside.

formalcohol (10% formalin with 70% alcohol)]. Staging is in accordance with Gosner (1960). Morphometric measurements were taken using slide verniers (to 0.1 mm). These include BL (Body Length: measured from snout tip to body-tail junction), TAL (Tail Length: from body-tail junction to tail tip), TL (Total Length: from snout tip to tail tip), MTH (Maximum Tail Height: greatest distance between dorsal and ventral fin margins), IOD (Inter-Orbital Distance: between centres of the pupils), IND (Inter-Narial Distance: between centres of narial apertures); abbreviations and definitions follow Altig and McDiarmid (1999). In addition, BW (Body Width: widest part of body), BH (Body Height: measured at mid-body), and ODW (Oral Disc Width) were also taken. Description of oral apparatus and labial tooth row formula (LTRF) is in accordance with Altig (1970). Reference to specific row/s of labial tooth/teeth follows Altig and McDiarmid (1999), e.g., A-1, P-1 refers to the first labial tooth row of the anterior and posterior labia, respectively.

DESCRIPTION OF TADPOLE

Diagnosis.- A benthic larval form inhabiting lentic microhabitat of stagnant, temporal forest pools. Medium sized tadpole, total length up to ca. 49 mm. Dorsum, flanks and tail muscle with background colour of light brown; dorsum with distinct, diagonal, dark brown stripes (Stage 34 onwards, orientation as in adults); flanks and anterior portion of venter with dark brown reticulations and spots, rest of venter white. Dark brown reticulation/spots continue from body-tail junction onto tail muscle and fins. Pineal spot present on head. Dermal glandules present over entire body, but absent from tail. LTRF 2(2)/3(1).

Larval morphology.- (Fig. 1) Body ovoid, snout broadly rounded, BW 0.60-0.73 of BL; BH 0.69-0.86 of BW, slightly depressed; maximum width at mid-body; eyes dorsal, directed laterally, not visible from below, IOD 0.54-0.62 of BW, 1.97-2.81 of ODW; nostrils dorsal, open, slightly nearer to snout tip than eye; IND 0.31-0.48 of IOD; spiracle sinistral, positioned at

TABLE 1: Developmental changes in BL (body length) and TL (total length) of larval *Rana miopus* (ZRC.1.2822-2871; n = 49, Stages 26-42).

Gosner Stage	No.	BL (mm)	TL (mm)
26	4	9.9-11.0	24.3-27.2
27	4	12.4-13.0	26.8-29.9
28	2	12.8-13.3	30.4-32.0
29	1	13.7	31.6
30	5	13.1-15.2	31.9-34.6
31	1	14.6	35.0
32	1	16.1	37.6
33	3	14.7-15.6	34.5-37.8
34	6	15.1-17.9	35.6-41.6
35	1	15.9	36.7
36	2	17.2-17.4	40.2-40.9
37	3	17.0-17.3	40.0-40.9
38	2	17.8-18.6	42.5-45.5
39	1	19.7	48.8
40	11	18.5-23.7	46.6-58.7
42	2	19.9-20.1	42.9-43.0

lateral, extended as a short tube, fused to body wall, spiracular opening directed posteriorly, snout-spiracle 0.57-0.74 of BL; anal tube dextral, continuous with ventral fin. Tail lanceolate, dorsal fin margin weakly convex, ventral fin margin less so, both margins gradually tapering towards a narrowly pointed tip. TAL 1.36-1.71 of BL, MTH 0.29-0.37 of TAL; caudal muscle deeper than both fins for proximal 1/2 of tail. Dorsal fin originating at body-tail junction, gently sloping towards mid-tail convex, dorsal fin slightly deeper than ventral. Pineal spot visible, anterior to interorbital axis. Lateral line pores, naso-lacrymal grooves visible. Numerous round dermal glandules scattered separately throughout dorsal, lateral and ventral surfaces of body, with dense aggregations along both dorsolateral axes, but not present in tail muscle/fins.

Colour/Markings.- Background colour of dorsum, flanks and tail muscle light brown. Flanks and anterior 1/3-1/2 of venters with dark brown spots/reticulation, rest of venter white.

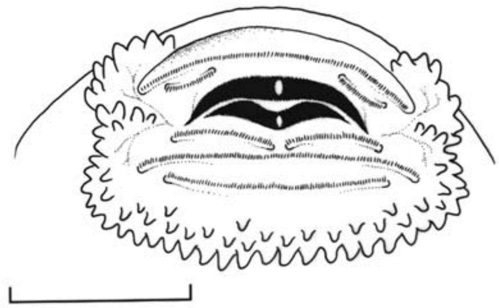

FIGURE 2: Oral disc of *Rana miopus* tadpole, LTRF 2(2)/3(1); scale bar = 2 mm.

Three to four thin, diagonal (anterior left to posterior right), dark brown stripes evenly arranged on dorsum exhibiting in Stages 34 and more advanced larvae. Spiracular tube unpigmented. Similar dark brown spots/reticulations continue from body onto tail muscle and translucent fins.

Oral Disc.- (Fig. 2) Mouth ventral, sub-terminal, ODW 0.24-0.35 of BW, marginal papillae of anterior labium confined to lateral portions, consisting of short, single row of triangular papillae; lower labium lined with two to three rows of short, triangular (outer) and conical (inner) papillae, without median gap. Jaw sheaths finely serrated, upper jaw sheath with relatively straight margin centrally, arching posteriorly at the sides, without median convexity; lower jaw sheath with a "v" arch, both jaw sheaths edged with black.

LTRF.- 2(2)/3(1); A-1 undivided, A-2 broadly divided by upper jaw sheath, 1/5-1/6th width of A-1, confined to lateral regions. P-1 narrowly divided, P-2 and P-3 undivided, P-3 3/4-4/5th of P-2.

Development.- (Table 1) Upon eventual tail resorption, metamorphs would attain an SVL of ca. 20 mm. The glandules do not appear to be lost or reduced, but instead take on an increasingly granular appearance, resembling the skin texture of the adults.

ACKNOWLEDGEMENTS

We are grateful to Peter Ng and Kelvin Lim for granting access to the specimens and literature (RMBR). Mitsuru Kuramoto and Robert Inger improved the manuscript with their constructive reviews.

LITERATURE CITED

ALTIG, R. 1970. A key to the tadpoles of the continental United States and Canada. *Herpetologica* 26: 180-207.

________ & R. W. McDIARMID. 1999. Body plan: development and morphology. *In*: Tadpoles: the biology of anuran larvae. pp: 24-51. R. W. McDiarmid & R. Altig (Eds). The University of Chicago Press, Chicago & London.

BERRY, P. Y. 1975. The amphibian fauna of Peninsular Malaysia. Tropical Press, Kuala Lumpur. x + 130 pp.

BOULENGER, G. A. 1918. Description of a new frog (*Rana miopus*) from Siam. *J. nat. Hist. Soc. Siam* 3(1): 11-12.

________. 1920. A monograph of the South Asian, Papuan, Melanesian and Australian frogs of the genus *Rana*. *Rec. Indian Mus.* 20: 1-226.

BOURRET, R. 1941. Les batraciens de l'Indochine. Institut Océanographique de l'Indochine, Hanoi. x + 547 pp.

FROST, D. R. 1985. Amphibian species of the world: a taxonomic and geographic reference. Allen Press Inc. and the Association of Systematics Collection, Lawrence, Kansas. 732 pp.

GOSNER, K. L. 1960. A simplified table for staging anuran embryos and larvae with notes on identification. *Herpetologica* 16: 183-190.

GRANDISON, A. G. C. 1972. The Gunong Benom Expedition 1967: 5. Reptiles and amphibians of Gunong Benom with a description of a new species of *Macrocalamus*. *Bull. British Mus. nat. Hist. (Zool.)* 23(4): 43-101.

LEONG, T.-M. 2000. *Rana miopus*– Geographic distribution. *Herpetol. Rev.* 31(3): 183.

________. 2002. Status of larval identities among the Peninsular Malaysian Anura. *Herpetol. Rev.* 33(3): 171-174.

SMITH, M. A. 1930. The Reptilia and Amphibia of the Malay Peninsula. *Bull. Raffles Mus.* 3: 1-149.

TAYLOR, E. H. 1962. The amphibian fauna of Thailand. *Univ. Kansas Sci. Bull.* 43: 265-599.

Received:25 March 2003.
Accepted: 12 April 2003.

Hamadryad Vol. 27, No. 2, pp. 179 – 184, 2003.

THE THERMAL BEHAVIOUR, DIURNAL ACTIVITY PATTERN AND BODY TEMPERATURE OF *VARANUS SALVATOR* IN CENTRAL SRI LANKA

Nimal D Rathnayake[1], Nadeeka D Herath[2], Kalinga K Hewamathes[3] and Susanka Jayalath[4]

[1]'Thilina', Galgediyawa, Gampola, Sri Lanka. Email: nimaldr@yahoo.com
[2]Kovilawatte, Alpitiya, Devanagala (via Mawanella), Sri Lanka.
Email: darshani79 @ hotmail.com
[3]90/23, Deiyannewela, Kandy, Sri Lanka.
[4]Tiverton Gardens, Peradeniya, Sri Lanka.
(with three text-figures)

ABSTRACT.– The thermal behaviour and diurnal activity patterns of *Varanus salvator* were studied in Kandy, central Sri Lanka. The frequency of activity types observed varied during different times of the day. Early in the morning, more lizards were observed foraging in water, but by the late morning, activity in water decreased. Instead, more individuals were seen basking or resting out of water by late morning and during the afternoon. Fewer active lizards were seen during continuous rainy days. The mean body temperature of active lizards was 28.9º C, which is similar to that reported from other studies on the species, and is lower than that reported for other varanid lizards. Body temperature of lizards foraging in the water (mean 26.2C ± SD 2.2) was also lower than the body temperature of animals that were resting or basking (mean 29.1 ± SD 3.6).

KEYWORDS.– *Varanus salvator*, thermal behaviour, diurnal activity pattern, body temperature, Sri Lanka.

INTRODUCTION

As poikilotherms, lizards adjust their body temperature by seeking warmer or cooler microhabitats to raise or lower body temperature, depending on thermal requirements for different activities (Pianka, 1986). The physiological adaptations and behavioural responses of lizards to ambient temperature vary considerably among taxa, ranging from the thermoconformers that allow their body temperature to vary with ambient temperature, to the thermoregulators that actively seek out appropriate habitats and microhabitats that allow them to regulate the body temperature (see review by Huey, 1982).

There have been a number of studies on thermal behaviour, diurnal activity patterns and body temperature of the water monitor, *Varanus salvator* (Pandav and Choudhury, 1996: Wikramanayake and Green, 1989: Dryden and Wikramanayake, 1991; Traeholt, 1997; Wikramanayake and Dryden, 1993; Wikramanayake, 1995; Wikramanayake and Dryden, 1999; Rathnayake, 2000a). While these investigations of the inter-relationships between climate, habitat and the activity patterns are of crucial importance in understanding the ecology and behaviour of ectotherms, they are also necessary for conservation of the species.

Attaining a length of 3 m, *Varanus salvator* is the second largest living lizard in the world. Despite its wide range, from the north-eastern India to the eastern Indonesian islands (Erdelen, 1998), the species is threatened by widespread hunting. Unlike in most other countries in its range, the species is not hunted extensively as food or body parts in Sri Lanka. It has therefore adapted to an urban lifestyle and can be frequently seen in large cities.

Previous studies of the water monitor lizard have been in natural settings, either in protected areas (Wikramanayake and Dryden, 1999) or in

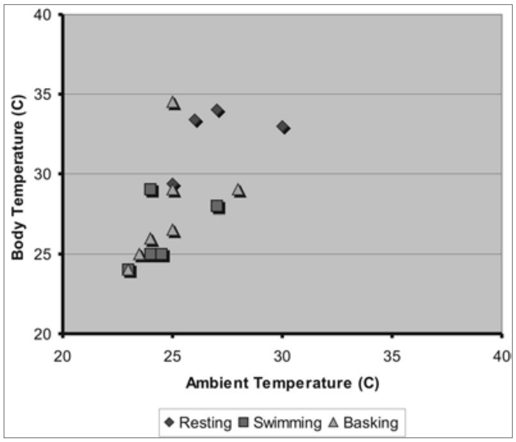

FIGURE 1: Relationship between body temperature and ambient temperature of active *Varanus salvator* in Kandy, central Sri Lanka

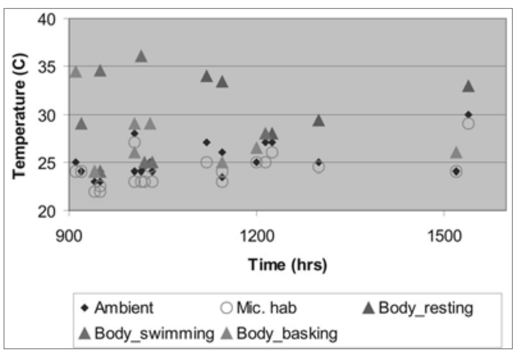

FIGURE 2: Relationship between ambient, microhabitat and body temperatures, activity and time of day in *Varanus salvator* in Kandy, central Sri Lanka.

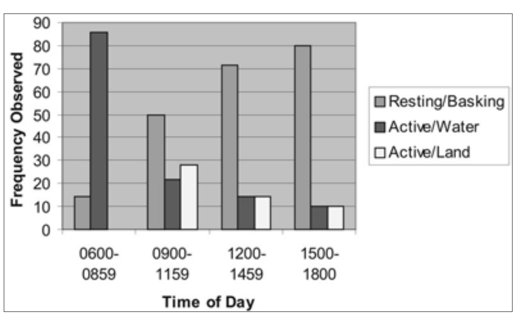

FIGURE 3: Frequency distribution of activity types in *Varanus salvator* throughout the day in Kandy, central Sri Lanka.

rural environments (Wikramanayake and Green, 1989) where they live under natural conditions. In this paper, we present results of the thermal ecology of *Varanus salvator* living in an urban setting, and compare the results of the monitors, inhabiting natural environments.

STUDY AREA AND METHODS

This study was conducted in Kandy, in central Sri Lanka, and was focussed around the Kandy Lake, a shallow, 18 ha man-made lake in the heart of the city of Kandy. The 3.3 km perimeter is lined with *Pandanus tectorius, Tabebuia rosea, Acacia auriculiformis, Mangifera indica, Peltophorum pterocarum, Anona glabra, Roystonia regia* and *Swietenia mecrophylla.*

During the period from December 1999 to June 2001, 76 individual lizards were observed, and 20 were captured to record body temperatures. Ambient temperature, microhabitat temperature, and behaviour were recorded with each sighting. The monitor's immediate physical environment was considered as the microhabitat. When lizards were found on the ground, ambient temperature (Ta) was taken at ground level and when found above ground, ambient temperature was measured ca. 1 m above ground level. The weight (g), snout-vent length (cm) and the total length (cm) were also recorded. Body temperature (Tb) was recorded using a Schulthies thermometer inserted into the cloaca. We consider that the active lizards as those found outside during the day, rather than in burrows.

Data were analyzed by dividing the day into four equal three-hour time periods, from 0600 to 1800 h. The field observations in all four 3 h time classes were made during four days each (3 x 4 =12 h for each time classes).

RESULTS

Two animals that were captured while in the water were recorded with body temperatures of 34.6º and 36.1º C. Because, these animals were captured early in the morning, during overcast days and the ambient air temperature was considerably lower, we considered these two outliers as misreadings, and therefore omitted them from the correlation of ambient temperature and body

temperature (Fig. 1) and other calculations. Mean ambient temperature for corresponding reading was 25.1º C, while the mean body temperature of active lizards was 28.9º C ($P > 0.001$, df 18, $n = 18$). Among these, animals that were resting and basking had a wide range of body temperatures (24-34º C) with an average body temperature of 29.1º C (± SD 3.6, $n = 13$). This was considerably higher than the average body temperature (26.2º C; ± SD 2.2, $n = 5$) of animals that were swimming. The animals captured from water also had a narrower body temperatures in the range 24-29º C.

Individuals of *Varanus salvator* that were captured early in the morning had body temperatures that greater than the ambient or microhabitat temperatures (Fig. 2). The lowest body temperature (24º C) reading at 0940 and 0950 h during two different days may have been taken soon after leaving their nests. However, lizards that were captured while 'resting' in the open environments had relatively high body temperatures, between 33-34º C. Resting lizards were more frequently encountered in the evenings and during mid-mornings (Fig. 3). Most observations of swimming were made early in the morning.

Three instances of pseudo-combat were observed, once in the late morning and twice in the afternoon.

DISCUSSIONS

The body temperature of active *Varanus salvator* has been reported to be the lowest among the varanids (see Table 1), which may be due to its semi-aquatic habits. Wikramanayake (1995) wrote that water monitors have lower active body temperatures than Bengal monitors (*V. bengalensis),* which may enable them to commence actively early in the day when the ambient temperature is low, without having to bask and elevate body temperature. Therefore, the low active body temperature may be an ecophysiological adaptation related to the use of, and activity in, aquatic habitats by semi aquatic varanids. In foraging for fish and crabs (most preferred food items), fast and agile movements are restricted in the aquatic environments. Water also serves as a heat sink and rapidly cools a lizard with high body temperature. This would necessitate shuttling between feeding and basking sites, which could be costly in terms of both time and energy. By maintaining a lower body temperature, this species can therefore exploit cooler habitats while foraging. However, it is also known to select substrates with higher temperatures for basking (Pandav and Choudhury, 1996).

In this study, conducted in the wet zone hills of Sri Lanka, the body temperatures of water monitors ranged from 24º to 34.5º C with a mean body temperature of 28.9º C (Table 2). Wikramanayake and Green (1989) and Wikramanayake and Dryden (1993) found the mean active body temperature of water monitors to be 29.9 and 30.4º C, respectively, in dry-zone habitats of Sri Lanka. Traeholt (1995) recorded the field active body temperature of water monitor as 30.4º C in West Malaysia. As per results, the mean body temperature recorded in this study is less than these mean body temperatures of other studies on water monitors in Sri Lanka. Although the available data are not conclusive, the montane wet zone aquatic habitats tend to be cooler than the dry zone aquatic habitats, which may contribute to the lower body temperature. However, more detailed research is needed to confirm this trend.

These results, however, clearly show that water monitors always keeps the body temperature higher than the ambient temperature. Although *Varanus salvator* maintains a fairly constant body temperature through out the day, the cloacal temperature of the lizards captured at any time of the day always exceeded the ambient air temperature.

Varanus salvator spends a considerable amount of time being inactive (Wikramanayake, 1995). Normally body temperatures of inactive animals tend to be lower than active animals. Dryden and Wikramanayake (1991) also suggested that water monitors thermoregulate to achieve their respective body temperature by choosing appropriate microhabitats and by being active during the times of the day which are optimal for their lower body temperature. Thus, they

TABLE 1: Comparative body temperatures of varanids. Source: Thompson et al. (1999).

SPECIES	Tb° C	SOURCE
Varanus bengalensis	34.5	Wikramanayke and Green,1989
V. bengalensis	32.6	Auffenberg, 1994
V. caudolineatus	37.8	Pianka,1994
V. eremius	37.3	Pianka,1994
V. giganteus	36.7	Pianka,1994
V. giganteus	36.4	Heger and Heger, 1993
V. gilleni	37.4	Pianka,1994
V. gouldii	37.1	Licht et al.,1996
V. gouldii	35.9	Christian and Weavers, 1996
V. griseus	36.1	Vernet et al.,1988
V. komodoensis	35.5	Wikramanayake et al.,1993
V. komodoensis	32.0-40.0	Auffenberg, 1981
V. mertensi	34.0	Christian and Weavers, 1996
V. olivaceus	31.0-32.2	Auffenberg, 1988
V. panoptes	36.4	Christian and Weavers, 1996
V. rosenbergi	35.6	King,1980
V. rosenbergi	36.3	Christian and Weavers, 1996
V. s. salvator	30.4	Traeholt, 1995
V. salvator	29.9	Wikramanayake and Green, 1989
V. salvator	30.4	Wikramanayake and Dryden, 1993
V. salvator	28.9	This study
V. scalaris	38.9	Christian and Bedford, 1996
V. tristis	34.8	Pianka, 1994
V. tristis	33.2	Thompson et al.,1999

TABLE 2: Body temperature (Tb) parameters of *Varanus salvator* in Kandy, and mean ambient temperature.

Minimum body temperature	24.0°C
Maximum body temperature	34.5°C
Mean body temperature	28.9°C
Mean ambient temperature	25.1°C
N	18

are usually active in water during the early hours of the day, when ambient temperatures are lower. During this time, the water temperatures tend to be warmer and similar to body temperatures, than do ambient air temperatures. In the present study, we also observed that most of the basking lizards choose warmer areas (e.g., open wooden surfaces, exposed ground areas, hot sand with grass or litter, tree branches etc.) and cooler areas for resting and foraging (tree branches well covered with a canopy of leaves, mud, grass in water, tree bases in water, cool shady areas, etc.).

Although ambient temperatures drop during the night, water temperatures remain more constant and higher. Thus, being in the water or in the refuge of dense vegetation, probably enables *Varanus salvator* to maintain body temperatures, a few degrees above ambient temperatures over night and to be active earlier in the following morning as also observed in the dry zone by Wikramanayake and Green (1989).

The correlation between ambient temperature and the body temperature (R = 0.65) in the present study was similar to that found by Wikramanayake and Green (1989), in the dry zone of southern Sri Lanka (R = 0.69, N = 12).

According to these observations, the species normally leave their nests between 0600-0900 h and return to their shelters between 1500-1800 h. However, these timings are dependent on the weather conditions, i.e., whether it is rainy, overcast, or sunny. The timing of return to shelter is also associated with approaching sunset and the subsequent fall of temperature (Rathnayake, 2000a). While swimming, animals were observed most frequently early in the morning. By late mornings and early afternoons, more animals were observed basking (Table 3).

Wikramanayake and Green (1989) also found that their study population of *Varanus salvator* was more active in water early in the mornings, between 0600 – 0800 h and again in the evenings, between 1600-1800 h. This is probably because they can forage during periods of low ambient temperature since their active body temperature is low. In this study, monitors were found slowly moving in water between 0600-0900 h, which would have been soon after leaving their shelter.

TABLE 3: The relationship between activity and time classes in *Varanus salvator*.

activity	Time Class 0600-0900	0900-1200	1200-1500	1500-1800	N Lizards
resting	01	04	08	07	20
basking	01	12	02	01	16
swimming	12	07	02	01	22
foraging	-	08	02	01	11
walking	-	01	-	-	01
pseudo-combat	-	02	-	04	06
n lizards	14	34	14	14	76

Basking animals were found on trees over 15 m above ground. Therefore, there is a similarity between the results of these two studies.

Most of the time, monitors were observed to move only to find food. Males reach the peak of their activities during the mating season (seeking females) and the females are most active immediately after the mating period in the nesting sites (Bennett, 1995). During the study, of the three observed pseudo-combat activities, two were recorded in *Pandanus tectorius* bushes with well-grown prop roots. We suggest that the roots provide favorable conditions for the activity. Two pseudo-combat activities were recorded late in the evenings in May 2000 and the other was around 0950 h on 18 December, 1999. The animals spent around 45 to 50 min engaged in pseudo-combat behaviour.

In the present study, major activities such as basking, foraging, resting and swimming reached a peak at different ambient temperatures. Of the 76 lizards recorded, 16 were found basking in an ambient temperature range of 22-30º C, while 11 were observed foraging in an ambient temperature range of 20-27º C. The lizards that were swimming were in an ambient temperature zone of 22-29º C. According to Pandav and Choudhury (1996), water monitors in the Bhitarkanika Mangroves of Orissa, eastern India were basking, foraging, and resting when peak ambient temperatures were 25º C, 31º C and 29º C, respectively. Looking at the relationship between ambient temperature and the activity pattern, it is evident that the species is more active during certain temperature classes. In this study, 25-31º C seems to be the preferred temperature zone for activity. This is rather similar to the preferred temperature range for activity by the species in Orissa, which was 23-31º C (Pandav and Choudhury, 1996).

The present study site is in the wet zone hills, whereas the previous studies of *Varanus salvator* in Sri Lanka were conducted in the lowland, dry zone areas. Nonetheless, body temperatures and thermal biology of these lizards living in both ecosystems are similar, and it is evident that the thermal biology of the species in an urban environment is similar to those living in more natural conditions.

ACKNOWLEDGEMENTS

We sincerely thank Eric D. Wikramanayake, Anslem de Silva, Harry V. Andrews, Channa Bambaradeniya and Jayantha Jayawardane for their guidance and comments on this study and providing some of the relevant literature, and H. D. Rathnayake (Director– Research and Training) and J. P. Jayasekara (former Director, DWLC) for granting approval to this study. Finally, we thank Ayoma Rathnayake, Sachintha Hewawasam, Hiran Wijesinghe, Padmini Dassanayake and Mohomed M Rizvi for various courtesies.

LITERATURE CITED

BENNETT, D. 1995. A little book of monitor lizards. Viper Press. Aberdeen. 208 pp.

DRYDEN, G. L & E. D. WIKRAMANAYAKE. 1991. Space and time sharing by *Varanus salvator* and *Varanus bengalensis* in Sri Lanka. *Mertensiella* (2): 111-119.

ERDELEN, W. 1998. Geographic distribution, biology and conservation of water monitor (*Varanus salvator* Laurenti 1788). *In*: Proc. Intl. Conf. Biol. & Conserv. Amphibians & Reptiles of South Asia. pp: 223-231. A. de Silva (Ed). Amphibia and Reptile Research Organisation of Sri Lanka, Gampola.

HUEY, R. B. 1982. Reptile physiology and ecology. *In*: Biology of the Reptilia. Vol. 12. pp: 25-91. C. Gans & F. H. Pough (Eds). Academic Press, London and New York.

PANDAV, B. & B. C. CHOUDHURY. 1996. Diurnal and seasonal activity patterns of water monitor (*Varanus salvator*) in the Bhitarkanika mangroves, Orissa, India. *Hamadryad* 21: 4-12.

PIANKA, E. R. 1986. Ecology and natural history of desert lizards. Princeton Univ. Press, Princeton, New Jersey. xii + 208 pp; 8 pl.

RATHNAYAKE, N. D. 2000a. Diurnal behavior patterns of water monitor *Varanus salvator* (Sauria: Varanidae). *Sri Lanka Natural.* 3(2): 31-33.

________. 2000b. Sri Lankan monitor lizards. *Sri Lanka Nature* 2 (5): 52-53.

THOMPSON, G. G., E. R. PIANKA & M. DE BOER. 1999. Body temperatures of an arboreal monitor lizard *Varanus tristis* (Squamata: Varanidae), during the breeding season. *Amphibia –Reptilia* 20: 82-88.

TRAEHOLT, C. 1995. A radio-telemetric study of the thermoregulation of free living water monitor lizard, *Varanus salvator salvator. J. Comp. Physiol. B* 165: 125-131.

________. 1997. Activity patterns of free living water monitor lizards, *Varanus salvator*. *Malayan nat. J.* 50: 301-315.

WIKRAMANAYAKE, E. D. 1995. Activity and thermal ecophysiology of two sympatric monitor lizards in Sri Lanka. *J. South Asian nat. Hist.* 1(2): 213-224.

________& G. L. DRYDEN. 1999. Implications of heating and cooling rates in *Varanus salvator* and *Varanus bengalensis*. *Mertensiella* (11): 149-156.

________& B. GREEN. 1989. Thermoregulatory influences on the ecology of two sympatric varanids in Sri Lanka, *Biotropica* 21(1): 74-79.

________&________ . 1993. Thermal ecology of habitat and microhabitat use by sympatric *Varanus bengalensis* and *V. salvator* in Sri Lanka. *Copeia* 1993(3): 709-714.

Received: 5 December 2001.
Accepted: 10 December 2002.

Hamadryad Vol. 27, No. 2, pp. 185 – 192, 2003.

HATCHING SUCCESS AND ORIENTATION IN *LEPIDOCHELYS OLIVACEA* (ESCHSCHOLTZ, 1829) AT RUSHIKULYA ROOKERY, ORISSA, INDIA

Basudev Tripathy[1], Bivash Pandav[1] and R. C. Panigrahy[2]

[1]Wildlife Institute of India, Post Box No. 18, Chandrabani, Dehradun 248 001, India.
[2]Department of Marine Sciences, Berhampur University, Berhampur 760 007, India.
Email: tripathyb@yahoo.co.uk
(with five text-figures)

ABSTRACT.– **The hatching success and beach orientation of olive ridley sea turtle (*Lepidochelys olivacea*) hatchlings were studied during a post arribada season (March 1996 - May 1996) at the Rushikulya rookery along the Orissa Coast, India. A total of 40 nests were observed for two weeks in order to obtain information on time of emergence of hatchlings and the hatching time lag, emergence success, and orientation of the hatchlings. Additional 50 successful nests were excavated to determine hatching success. The emergence success observed during the study was 98 ± 18.86%. Hatchlings showed strong photo-tactic orientation (89%). Average clutch size was 126.00 ± 19.20 eggs. In majority of the excavated nests (99%), all the eggs had hatched, while in the remaining few nests, eggs failed to hatch.**

KEYWORDS.– ***Lepidochelys olivacea,* hatching success, orientation, light pollution.**

INTRODUCTION

Of the world's seven species of sea turtles, five are known to inhabit Indian coastal waters and its bay islands including Lakshadweep (Kar and Bhaskar 1982). Barring the loggerhead turtle (*Caretta caretta*), the other four species - the leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), green turtle (*Chelonia mydas*) and the olive ridley sea turtle (*Lepidochelys olivacea*) - are known to nest along the mainland and bay islands of India. All these five species are legally protected under the Indian Wild Life (Protection) Act, 1972, and included in Appendix I of CITES.

The olive ridley sea turtle is the most numerous species along the mainland coast and nests sporadically along the east and west coast of India. However, mass nesting takes place only along the Orissa coast (Kar and Bhaskar, 1982). The olive ridley sea turtle is well known for its synchronous nesting behaviour also known as 'arribada' (Spanish for "arrival") in which several hundreds of thousands of female olive ridleys nest en-masse. The major nesting aggregations for olive ridley occur in few beaches of Costa Rica and México in the east Pacific (Pritchard, 1997), and in Orissa on the east coast of India (Bustard, 1976; Pandav et al., 1994a). The 480 km coastline of Orissa harbours three mass nesting grounds namely the Gahirmatha rookery along the northern Orissa coast, the Devi rookery located 100 km south of Gahirmatha, and the Rushikulya rookery near the mouth of River Rushikulya in the southern Orissa coast. Between January and May every year, more than half a million olive ridley turtles have been counted nesting en-masse at these three rookeries (Dash and Kar, 1990; Pandav et al., 1994a).

Nesting of olive ridley sea turtles near the mouth of River Rushikulya is known since 1990 (Panigrahy et al., 1990) and mass nesting was discovered in 1994 (Pandav et al., 1994b) and since then, the estimates of nesting turtles from this rookery have been regularly available to the scientific community (reviewed in Pandav, 2000). However, there is little or no information available on other aspects of olive ridley sea turtle nesting biology from this rookery. No information is available on the behaviour of hatchlings, particularly their orientation immedi-

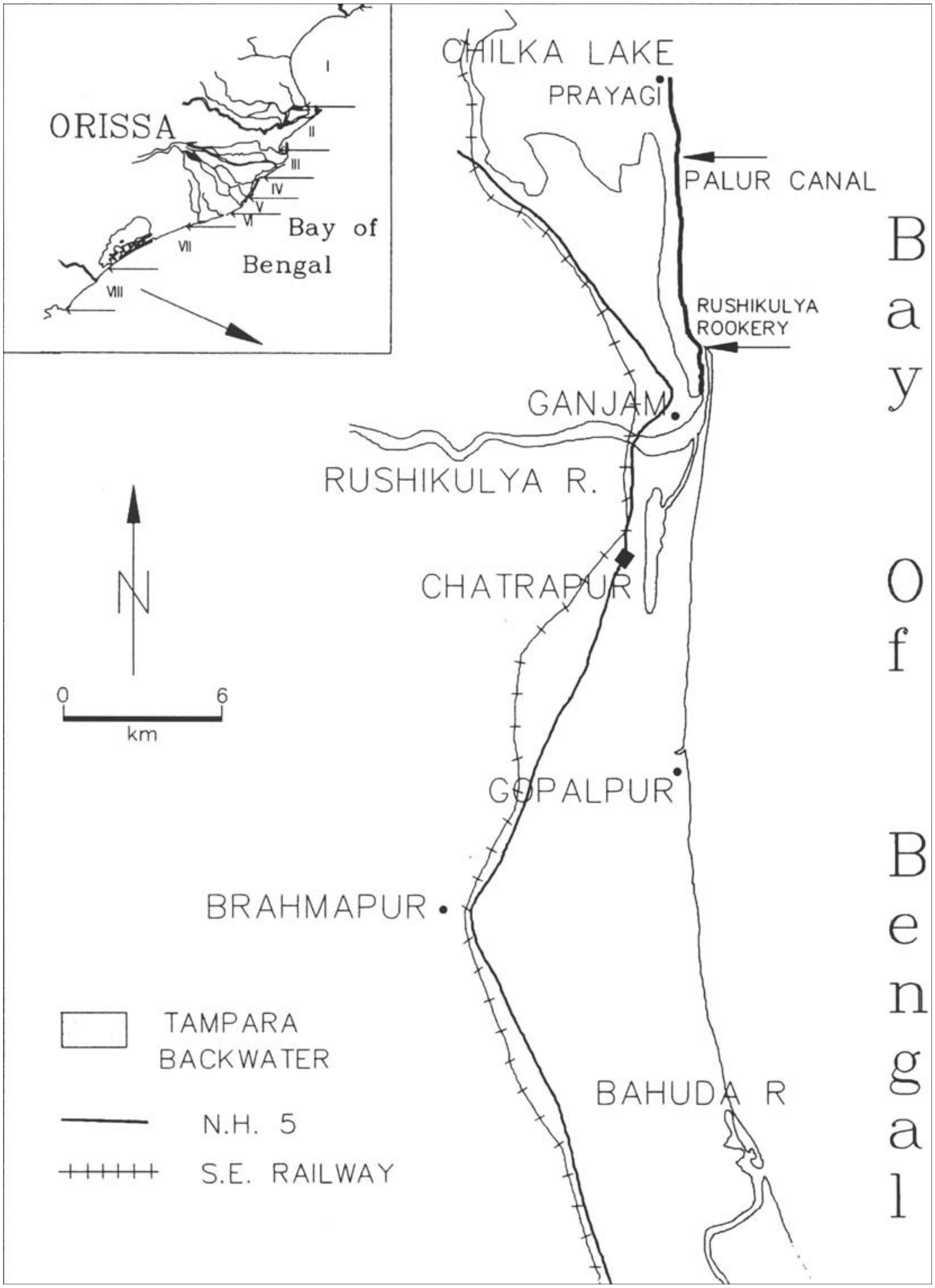

FIGURE 1: Map of Rushikulya sea turtle rookery, Orissa coast, eastern India.

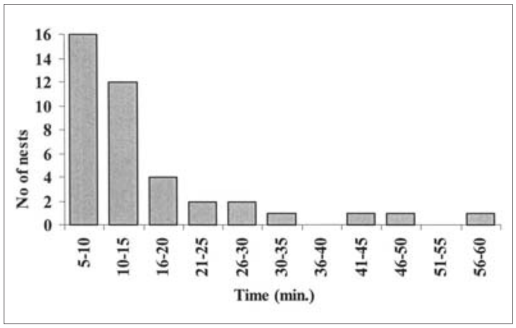

FIGURE 2: Time lag of emergence of olive ridley hatchings from the nests at Rushikulya rookery, Orissa.

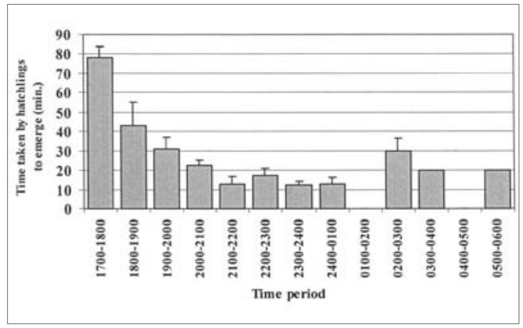

FIGURE 3: Effect of time period on time taken to emerge by hatchling of olive ridley sea turtles at Rushikulya rookery, Orissa.

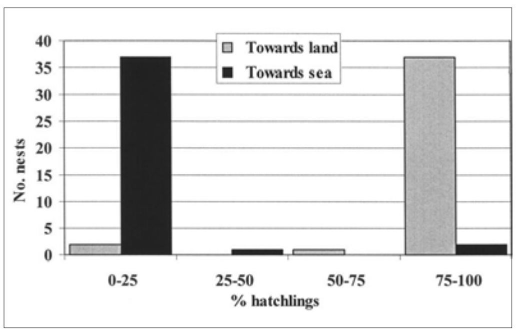

FIGURE 4: Orientation of sea turtle hatchlings after emerging out from the nest at Rushikulya rookery, Orissa.

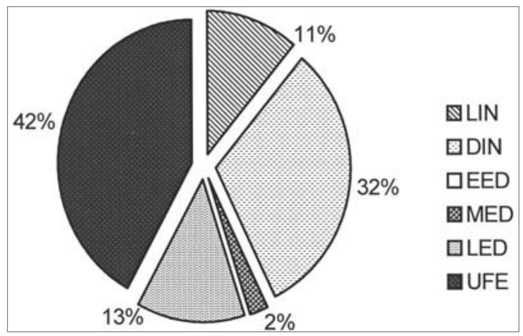

FIGURE 5: Different stages of mortality found inside the unhatched eggs of olive ridley sea turtles at Rushikulya rookery, Orissa.

ately after they emerge from the nest. Determination of clutch size, emergence success and hatching success provides information fundamental to the conservation and management of sea turtle. This information is essential to understand the suitability of a nesting beach and general health of a nesting population (Miller, 1997; 1999). In this context, this work was undertaken to study the olive ridley sea turtle hatchlings at the Rushikulya River mouth of Orissa coast. In this paper, we report hatching success and beach orientation of hatchlings. These findings are discussed in the light of conservation measures required at Rushikulya.

MATERIALS AND METHODS

Study area.- The mass nesting beach is located on the sand spit along the northern side of Rushikulya River mouth. The rookery is situated along the south Orissa coast and is 320 km south of the mass nesting beach of Gahirmatha (19º 22’ N; 85º 02’E; Fig. 1). The Rushikulya River estuary opens to the Bay of Bengal near the Ganjam town. The estuary is connected with the Chilka Lake through the man-made Palur Canal or French Canal. The topography of the estuary has undergone many recognizable changes during the past one decade (Gouda and Panigrahy, 1992). During the 1989 flood, a new river mouth was formed opposite to Potagarha village on the barrier sand spit that separated the two ridges of the estuary from the sea. The old mouth near the Gokhurkuda village has subsequently been filled up by sand. At present, an expanded sandy beach has developed on this old river mouth. The backwaters of Rushikulya River estuary runs parallel to the nesting beach for 1 km northwards forming a lagoon of its own. This lagoon is now connected with the Chilka Lake through the Palur Canal.

The nesting beach is characterized by ca. 1 m high scattered sand dunes. Natural vegetation in-

cludes psammophytes such as *Ipomoea pescaprae*, *Spinifex littoreus* and *Hydrophylax maritima*. One conspicuous feature of this beach is the absence of *Casuarina* plantations, which are otherwise found along the rest of the Orissa coast. Human settlements near the beach include the fishing villages of Purunabandha and Palibandha, and the major fish landing centres are Gokhurkuda, Kantiagarha and Nuagaon. The other features of this area are abandoned prawn farms that are behind the nesting beach and a chloro-alkali plant, which discharges mercury directly to the Rushikulya estuary. The Ganjam Township as well as the National Highway No. 5 is 1 km away from the mass nesting beach. At night, high illumination on the nesting beach occurs due to these permanent establishments.

METHODOLOGY

All observations on nests were made between March and May 1996. Areas with nests usually have loose surface sand, and could be identified easily. Nests with freshly emerging hatchlings were identified opportunistically during walks on the nesting beach between 1700-0500 h. Newly hatched turtles reach the nest surface and remain there for a few minutes before moving away (B. Tripathy, pers. obs.), and these nests did not have crawl marks around the nest. Location of all such nests, whenever encountered, was marked with a stick placed 30 cm away from the nest to avoid disturbing hatchlings. As soon as a nest with newly emerging hatchlings was encountered and marked, one observer (BT) began observations on the hatchlings. Time taken for emergence (from beginning of emergence of first hatchling until hatchlings stopped emerging) of each nest was noted. Orientation of each hatchling was also observed and the observer was always beside the nest to avoid being an obstruction to movement of hatchlings either away from the sea or towards it. For this purpose, a circle of 1 m radius was marked on the sand around the nest with a line running parallel to the sea. Movement of each hatchling was noted as towards land or sea depending on where it crossed the circle after emergence. We relied on the abundant moonlight to count hatchlings, and the use of searchlight was avoided throughout the study so as not to bias the movement of hatchlings. Complete observations of time taken for emergence and orientation could be taken for 40 nests. Non-parametric Kruskal-Wallis test was used to test effect of time on time taken by hatchlings to emerge.

Other nests from which hatchlings had emerged out completely were marked with a wooden stick approximately 30 cm away from the point of emergence. To determine hatching success, these nests were excavated four to five days after emergence of the hatchlings. This was because earlier observations have shown that though most of the hatchlings emerge together, some remain for a while longer and emerge slowly over the next couple of days (B. Pandav, unpubl.). The number of hatched eggshells was counted; only bigger eggshell pieces (>50% complete eggshell) were taken into consideration. The number of empty shells, unhatched eggs and abnormal eggs were also enumerated. The numbers of both live and dead hatchlings present in the nest were also counted to obtain a complete measure of hatching success. Information on hatching success was obtained for 50 nests.

To determine percentage fertility, unhatched eggs were cut open and examined. Eggs without visible embryo or blood formation were classified as infertile. The embryonic mortality was subclassified based on the level of embryonic development inside the eggs as follows:

(a) Early embryonic death (EED). Eggs showing sign of blood vessel formation or a small em-

TABLE 1: Clutch characteristics of olive ridley sea turtle from the published literature.

Source	No. of nests	Clutch size	
		Range	Mean eggs/nest ± SD
Dash & Kar (1990)	75	24 – 186	119.95 ± 29.26
Shanker (1994)	126	–	118.35 ± 8.78
Miller (1997)	–	–	109.90 ± 12.8
Tripathy et al. (in press)	14	95 – 128	110.57 ± 10.08
This study	50	68 – 163	126.00 ± 19.2

$$Clutch\,size \quad E \quad L \quad D \quad UL \quad UH \quad UTH \quad P$$

$$Hatching\ success \quad \frac{\#\,S}{\#\,S \quad \#\,UD \quad \#\,UH \quad \#\,TH \quad \#\,P} \quad 100$$

$$Emergence\,success \quad \frac{\#\,S \quad \#\,L \quad \#\,D}{\#\,S \quad \#\,UD \quad \#\,UH \quad \#\,TH \quad \#\,P} \quad 100$$

Where:

E	= Emerged	Hatchlings leaving or departed from nest
S	= Shells	Number of empty shells counted (>50% complete)
L	= Live in nest	Live hatchlings left among shells
D	= Dead in nest	Dead hatchlings that have left their shells
UD	= Undeveloped	Unhatched eggs with no obvious embryo
UH	= Unhatched	Unhatched eggs with obvious embryo
UHT	= Unhatched term	Unhatched with full term embryou in egg shell or piped
P	= Depredated	Open, empty or shell containing egg residue

bryo without pigmentation were considered as early embryonic death.

(b) Mid embryonic death (MED). Egg contains a small embryo with pigmented eyes, but unpigmented body measuring approximately 10-20 mm from head to tail were considered as mid embryonic death.

(c) Late embryonic death (LED). Egg having pigmented embryo (30 mm) with body formation were included under late embryonic death category.

The clutch size, hatching success and emergence success was calculated following Miller (1999).

RESULTS

Emergence.- Most hatchlings emerged at night (80% of nests), while few emerged during the mornings and evenings. The time taken for emergence of hatchlings from nests varied between 7 and 88 min with an average emergence time of 25.45 ± SD 19.76 min. In most of the nests, however, the hatchlings took between 5–30 min to emerge completely (Fig. 2), There was a significance difference in the time taken to emerge by hatchlings across different time periods (Kruskal-Wallis test, ^{2} = 23.26, d.f. = 10, p = 0.01). Hatchlings emerging during the evening took the longest time while those in the night emerged faster; there was insufficient information for nests where hatchlings emerged during the morning (Fig. 3).

Orientation.- In the 40 nests observed, orientation data was collected for 4,865 hatchlings. Of these, 89.26% oriented to land towards a source of artificial illumination, while the rest in the direction of the sea. The photo-tactic response of turtle hatchlings was evident (Fig. 4). The proportion of hatchlings orienting towards land in each nest varied from 0-100%, mean 83.94 ± SD 26.57.

Emergence success.- In the 50 nests excavated, 6,331 eggs were counted to determine incubation success. There were a total of 6,121 successfully hatched eggs found in the nest. During the nest excavation, 41 hatchlings (11%) were alive and 116 (32%) were dead in the nest. Among the unhatched eggs, 154 (42%) were infertile, and eight (2%) and 48 (13%) eggs in mid embryonic and late embryonic developmental stage, respectively, were recorded (Fig. 5). The overall emergence success of the nest was 98 ± 18.86%.

Estimated clutch size.- Clutch sizes determined during the study varied from 86 to 163, with a mean of 126.00 ± SD 19.2 eggs/nest.

Hatching success.- The percent hatching success ranged from 88.7 to 100% with a mean of 97.38 ± SD 18.86. Emergence success was 100% in 48 nests, but in two nests, majority of the hatchlings failed to emerge.

Most of the nest predation seems to takes place during the day. However, hatchlings on the beach in the morning were predated by feral dogs

(*Canis familiaris*), House crows (*Corvus splendens*), Brahminy kites (*Haliastur indus*) and Brown-headed gulls (*Larus ridibundus*).

DISCUSSION

The emergence of sea turtle hatchlings are recorded during night or cool hours of the day by many workers (e.g., Bustard, 1967; Fowler, 1979). During the night, the beach surface temperature is low and is known to favour emergence of hatchlings, and their movement towards the sea is guided by natural light in the horizon (Bustard, 1967; Witherington and Bjorndal 1991; O'Hara, 1980). During diurnal emergence, the heat generated by beach sand lowers their activity level, leaving them vulnerable to predation for a long time (Mrosovsky 1978). Besides, the hatchlings get desiccated and die due to high temperature during the day. Predation is much greater on hatchlings that emerge during the day than those that emerge at night, because most hatchlings predators are diurnal and hatchlings are visible on the sand (Stancyk, 1982; Brown and McDonald, 1995). Two advantages of night emergence have been suggested: (a) to minimize predation (Hendrickson, 1982) and (b) to avoid physical stress (Gyuris, 1993). The result of the present study corroborates the above observations. Most of the nests observed had night-time emergence, and hatchlings from very few nests emerged during cool hours, including evenings and early mornings. Also the time taken to emerge was shortest during the night which would be the coolest and darkest time.

A high emergence success (98%) was recorded during the present study, which is healthy for olive ridley sea turtles of Orissa. Similar emergence success was also observed along the Gahirmatha coast (98%: Dash and Kar, 1990) and Madras coast (94%: Shanker, 1994). All these studies show that the olive ridley sea turtles along the Indian coast enjoy favourable nesting conditions.

Correspondingly all 50 nests excavated showed an extremely high hatching success. Studies elsewhere have observed highly variable rates of hatching success of olive ridley turtles on the same beach depending on environmental conditions during the different nesting years. Dash and Kar's (1990) 11 years study in Gahirmatha beach showed a variation of 85.27 to 90.81% hatching success in different years. They attribute low hatching success to saline inundation by tidal action and other environmental parameters. In the present study, all nests excavated were free from saline inundation thus resulting in a high hatching success rate.

Clutch size calculated during this study used eggshells for the first time. The clutch size recorded falls within the range known for olive ridley sea turtles from India and elsewhere, although the mean is the highest known so far (Table 1). This study did not provide control for the bias that may result from counting eggshells, in determining clutch size. The results however, are not different from values obtained by counting freshly laid eggs, but studies to determine correction factors are required to be confident about clutch sizes obtained by counting eggshells.

During the present study, most of the hatchlings oriented towards the land, i.e., towards artificial illumination from the chloro-alkali plant, aquaculture farms, township and other permanent establishments adjacent to the Rushikulya nesting beach. When sea turtle hatchlings emerge on beaches with artificial light, they have been previously recorded to become disoriented and move away from sea, towards the source of light (Frick, 1976; Blair and Bjorndal, 1991). While moving towards the sea, hatchlings of green turtle and loggerhead also become distracted by reflective objects on the beach (Carr, 1952). The presence of artificial light near the nesting beach often causes mortality in hatchlings by directing them away from the sea (Peters and Verheijen, 1994). Such disorientation of hatchlings of hawksbill, green and loggerhead turtle have also been reported by Diamond (1976), Fowler (1979) and Erk'akan (1993). The nesting beach at Rushikulya is bordered by grasses, and hatchlings drawn away by artificial light enter these grass fields and get entangled in the grass. This causes a high mortality due to desiccation and predation by avian predators.

From the observations made on the sea turtle hatchlings at Rushikulya rookery, it is evident that sand dunes near the river mouth provide optimal nesting sites for these turtles, in terms of hatching success. But man-induced factors such as artificial lighting close to the nesting beach poses a great threat to the hatchlings thus endangering recruitment in this population. Although Rushikulya receives a smaller number of nesting turtles as compared to Gahirmatha, this study indicates that the hatching success at this rookery is high underscoring the importance of this site to maintain the olive ridley population visiting the Orissa coast. In view of this, strict measures to put off the lights near the nesting beach particularly during the nesting and hatching season around the Rushikulya rookery are necessary. This rookery is unprotected by law and requires stringent measures to maintain the quality of the beach as a nesting sites for olive ridley sea turtles.

ACKNOWLEDGEMENTS

We are thankful to the field assistants of Wildlife Institute of India (WII) at Rushikulya rookery for their help during the work. This paper is part of the first author's Master degree dissertation and he is grateful to the Department at Marine Sciences, Berhampur University for facilities to undertake this work. We thank B. C. Choudhury and Director, WII for facilities and infrastructure during the preparation of the manuscript. Kartik Shanker and Gopi Sundar provided inputs to the manuscript. Finally, we thank an anonymous referees for valuable comments on the manuscript.

LITERATURE CITED

BLAIR, E. W. & K. A. BJORNDAL. 1991. Influence of wavelength and intensity on hatchling sea turtle phototaxis: implication for sea finding behavior. *Copeia* 1991(4): 1060-1069.

BROWN, L. & D. W. MACDONALD. 1995. Predation on green turtle (*Chelonia mydas*) nests by wild canids at Akyatan beach, Turkey. *Biol. Conser*. 71: 55-60.

BUSTARD, H. R. 1967. Mechanism of nocturnal emergence from the nest in green turtle hatchlings. *Nature*, *London* 214-317.

________. 1976. World's largest sea turtle rookery? *Tigerpaper* 3: 3.

CARR, A. 1952. Handbook of turtles. Turtles of the United States, Canada, and Baja California. Cornell University Press, Ithaca, NY. 542 pp.

DASH, M. C. & C. S. KAR. 1990. The turtle paradise- Gahirmatha: an ecological analysis and conservation strategy. Interprint, New Delhi. 295 pp.

DIAMOND, A. W. 1976. Breeding biology and conservation of hawksbill turtles, *Eretmochelys imbricata* L., on Cousin Island, Seychelles. *Biol. Conser*. 9: 199-215.

ERK'AKAN. F. 1993. Nesting biology of loggerhead turtle, *Caretta caretta* L. on Dalyan beach, Mugla-Turkey. *Biol. Conser*. 66: 1-4.

FOWLER, L. E. 1979. Hatching success and nest predation in green turtle (*Chelonia mydas*) at Tortuguero, Costa Rica. *Ecology* 60: 946-55.

FRICK, J. 1976. Orientation and behavior of hatchlings green turtle *Chelonia mydas* in the sea. *Anim. Behav.* 24: 849-857.

GOUDA, R. & R. C. PANIGRAHY. 1992. Seasonal distribution and behavior of silicate in the Rushikulya estuary, east coast of India. *Indian J. Mar. Sci.* 24:111-115.

GYURIS, E. 1993. Factors that control the emergence of green turtle hatchlings from the nest. *Wildl. Res*. 20: 345-353.

HENDRICKSON, J. R. 1982. Nesting behavior of sea turtles with emphasis on physical and behavioral determinants of nesting success or failure. *In*: Biology and conservation of sea turtles. pp: 53-57. K. A. Bjorndal (Ed). Smithsonian Institution Press, Washington, D.C.

KAR, C. S. & S. BHASKAR. 1982. The status of sea turtle in the eastern Indian Ocean. *In*: Biology and conservation of sea turtles. pp: 365-372. K. A. Bjorndal (Ed). Smithsonian Institution Press, Washington D.C.

MILLER, J. D. 1997. Reproduction in Sea Turtle. *In*: The biology of sea turtles. pp: 51-53, P. L. Lutz & J. A. Musick (Eds). CRC Press. Boca Raton, FL.

________. 1999. Determining clutch size and hatching success. *In*: Research and management technique for conservation of sea turtles.

pp: 124-129, K. L. Eckert, K. A. Bjorndal, F. A. Abrell-Grobois & M. Donnelly (Eds). IUCN Marine Turtle Specialist Group Publication No. 4, Blanchard, Pennsylvania.

MROSOVSKY, N.1978. Orientation of marine turtles. *In*: Animal migration, navigation and homing. pp: 413-419. K. Schmidt-Koenig & W. T. Keeton (Eds). Springer Verlag, New York.

O'HARA, J. 1980. Thermal influences on the swimming speed of loggerhead turtle hatchlings. *Copeia* 1980(4): 773-780.

PANDAV, B. 2000. Conservation and management of olive ridley sea turtle (*Lepidochelys olivacea*) population along the Orissa coast. Unpublished Ph.D. dissertation, Utkal University, Bhubaneswar. 106 pp.

________, B. C. CHOUDHURY & C. S. KAR 1994 a. A status survey of olive ridley sea turtle (*Lepidochelys olivacea*) and their nesting beaches along the Orissa coast, India. Submitted to the Wildlife Institute of India, Dehradun. 48 pp.

________, ________ & ________ 1994b. Discovery of a new sea turtle rookery in Orissa, India. *Marine Turtle Newsl*. (67): 15-16.

PANIGRAHY, R. C. R. GOUDA, S. MISHRA & L. NAYAK. 1990. Availability of marine turtle eggs in Rushikulya estuary, east coast of India. *Indian Forester* 116: 515-516.

PETERS. A & K. J. F. VERHEIJEN, 1994. Impact of artificial lighting on the seaward orientation of hatchling loggerhead turtles. *J. Herpetol*. 28 (1): 112-114.

PRITCHARD, P. C. H. 1997. Evolution, phylogeny and current status. *In*: The biology of sea turtles. pp: 1-28. P. L. Lutz & J. A. Musick (Eds). CRC Press, Boca Raton, FL.

SHANKER, K. 1994. Conservation of sea turtles on the Madras coast. *Marine Turtle Newsl.* (64): 3-6.

STANCYK, S. E. 1982. Non-human predators of sea turtles and their control. *In*: Biology and conservation of sea turtles. pp: 139-152. K. A. Bjorndal (Ed). Smithsonian Institution Press, Washington, D.C.

TRIPATHY, B., K. SHANKER & B. C. CHOUDHURY. in press. A survey of olive ridley turtles and their nesting habitats in Andhra Pradesh on the east coast of India. *Oryx.*

WITHERINGTON, B. E. 1991. Orientation of hatchling loggerhead turtles at sea off artificially lighted and dark beaches*. J. Exp. Mar. Biol. Ecol.* 149:1-11.

________ & K. A. BJORNDAL. 1991. Influence of artificial lighting on the seaward orientation of hatchlings of loggerhead turtle (*Caretta caretta*). *Biol. Conser.* 55: 139-149.

Received: 28 March 2002.
Accepted: 17 April, 2003.

Hamadryad Vol. 27, No. 2, pp. 193 – 199, 2003.

FIRST RECORD OF THE CHINESE CROCODILE LIZARD FROM OUTSIDE OF CHINA: REPORT ON A POPULATION OF *SHINISAURUS CROCODILURUS* AHL, 1930 FROM NORTH-EASTERN VIETNAM

Le Khac Quyet[1] and Thomas Ziegler[2]

[1]Fauna and Flora International - Vietnam Programme, IPO Box 78, 55 To Hien Thanh, Hanoi, Vietnam.
Email: primates@ffi.org.vn
[2]Zoologisches Forschungsinstitut und Museum Alexander Koenig, Adenauerallee 160, 53113 Bonn, Germany.
Present address: Zoologischer Garten Köln, Riehler Straße 173, 50735 Köln, Germany.
Email: tziegler@zoo-koeln.de

(with five text-figures)

ABSTRACT.– Since its discovery in 1928, the monotypic Chinese crocodile lizard, *Shinisaurus crocodilurus* Ahl, 1930, has been known from a few populations from Guangxi Province in south-eastern China. We present observations from the first known population of this genus outside of China. In May 2002, the species was discovered in the evergreen forests of Yen Tu Nature Reserve, Quang Ninh Province, north-eastern Vietnam, at moderate elevations. This population is located ca. 80 km from the Vietnamese-Chinese border, about 500 km from the nearest population recorded in China. Data on the natural history of the Vietnamese *Shinisaurus* are provided and the conservation importance of this population discussed.

KEYWORDS.– Squamata, Shinisauridae, *Shinisaurus crocodilurus*, distribution, natural history, conservation, Vietnam.

INTRODUCTION

The Chinese crocodile lizard or crocodile-tailed knobby lizard, *Shinisaurus crocodilurus* Ahl, 1930, was discovered in 1928 during an expedition led by Professor Shin in Guangxi, South China (Mägdefrau, 1987). Ahl (1930) erected a new family (Shinisauridae) to accommodate the monotypic genus and species. Subsequently, McDowell and Bogert (1954) placed *Shinisaurus* together with the genus *Xenosaurus* of northern Central America in the family Xenosauridae, though retaining subfamily status (Shinisaurinae versus Xenosaurinae) for both genera (compare also Underwood, 1957; Rieppel, 1980; Good et al., 1993; Harvey, 1993). However, recent analyses argued for the validity of the family Shinisauridae Ahl, 1930 within the Anguinomorpha (e. g., Hu et al., 1984, Huang, 1992; Macey et al., 1999). For example, studies on hemipenial morphology (Böhme, 1988; see also F. Zhang, 1986; Ziegler and Böhme, 1997) reveal distinct differences between *Shinisaurus* and *Xenosaurus*, thus not support the accommodation of both within the Xenosauridae.

The Chinese crocodile lizard is known only from a restricted area in Guangxi Province (type locality: Yao shan = Dayao Shan, Kwangsi = Guangxi Zhuang Autonomous Region) where it occurs from 200 to 1,500 m a.s.l. along densely vegetated and slow running karst streams or ponds (Fan, 1931; Shen and Li, 1982; Mägdefrau, 1987; Zhang, 1988; Liu et al., 1989; Fu, 1991; Zhao and Adler, 1993; Mägdefrau, 1997).

Thousands of pet trade specimens have been reported (Mägdefrau and Schildger, 1993), and numerous papers both on its natural history in the wild and its care and breeding in captivity have been published (e. g., Wermuth, 1958; Zhang, 1981; Huang, 1983; Zhang, 1985; Wermuth, 1985; Wilke, 1985a, 1985b, 1985c, 1986; Laurens, 1986; Tang, 1986; Y. Zhang, 1986; Mägdefrau, 1987; Tokyo Zool. Park Society,

FIGURE 1: A *Shinisaurus* specimen from Yen Tu Nature Reserve, Quang Ninh province, north-eastern Vietnam.

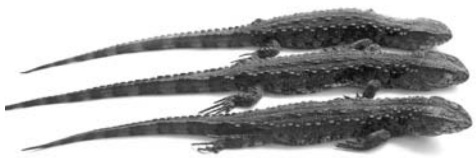

FIGURE 2: All three *Shinisaurus* voucher specimens from Vietnam.

1987; Zhang, 1987; Sprackland, 1989a, 1989b; Visser, 1989a, 1989b; Gritis, 1990; Thatcher, 1990; Kudrjawtsew and Wasiljew, 1991; Zhang, 1991; Sprackland, 1992; Grychta, 1993; Mägdefrau, 1997; Kudryavtsev and Vassilyev, 1998; Hermann et al., 1999; Rogner, 2002).

However, as stated by Mägdefrau (1987), further populations are likely to be found in the future. Because south-western Guangxi Province (where the currently known populations of *Shinisaurus crocodilurus* are restricted), borders north-eastern Vietnam, an occurrence in that country, although not documented in current herpetofaunal lists (e. g., Bourret, unpubl.; Bobrov, 1995; Nguyen and Ho, 1996), was suspected. A current overview provided in Ziegler (2002a, 2002b) demonstrate that estimations of the herpetofaunal diversity of Vietnam are still far from complete. Beside numerous first faunal records, about 30 amphibian and reptile taxa, including new species and new genera, were described in the last five years (from 1997 until 2001). More recently, two rare horned viperid snake species were rediscovered at the Vietnamese-Laotian border (e. g., Ziegler and Herrmann, 2002). As a part of our recent faunal survey in north-eastern Vietnam, we present the following report on the first population of the Chinese crocodile lizard outside of China.

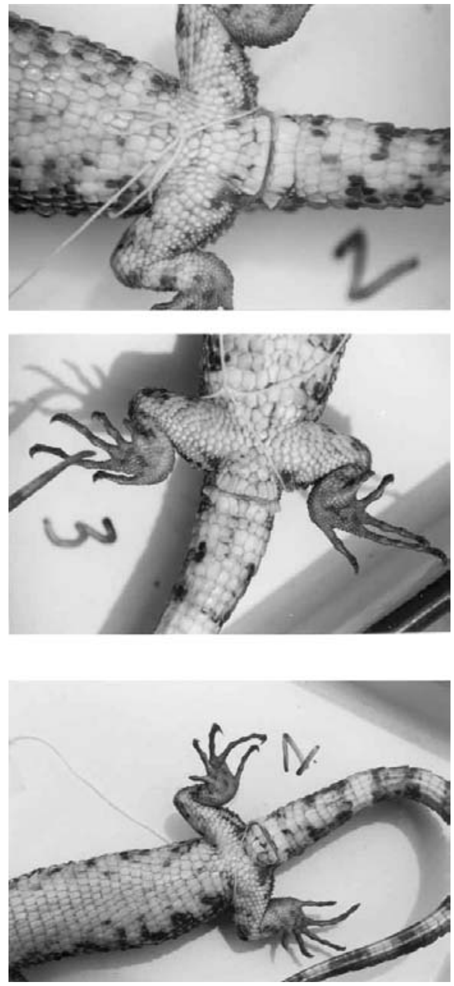

FIGURE 3: Ventral surfaces of the *Shinisaurus* voucher specimens from Vietnam.

MATERIAL AND METHODS

Voucher specimens were fixed in formalin, then preserved in 80% alcohol and are deposited in Vietnamese National University Hanoi (VNUH): VNUH 19.5.'02-1, VNUH 19.5.'02-2, and VNUH 19.5.'02-3.

Measurements were taken from preserved specimens to the nearest mm using a meter stick or a sliding vernier caliper. Abbreviations include: SVL = snout-vent length; TaL = tail length; TL = total length; HL = head length; HW = maximum head width.

FIGURE 4: Map of northern Vietnam and south-eastern China showing known localities (X) of *Shinisaurus crocodilurus* within Yen Tu Nature Reserve and in Guangxi Province after Y. Zhang (as presented as approximate locality dots in Mägdefrau 1987, 1997).

RESULTS AND DISCUSSION

An examination of three voucher specimens (see Figs. 1-3) reveal all diagnostic characters provided for *Shinisaurus* by Zhao and Adler (1993). Discovery of the new population was made during the early summer in Yen Tu Nature Reserve, Quang Ninh Province, north-eastern Vietnam, ca. 80 km from the border with China (Fig. 4). Although the first herpetological surveys were carried out in Yen Tu mountain area (Department of Zoology, IEBR 2000, Nguyen et al., 2000), no specimens of *Shinisaurus* were recorded. Yen Tu Nature Reserve (alternative site name: Nui Yen Tu) lies within Bac Giang and Quang Ninh Provinces (21° 10’ N; 106° 42’ E). It is part of one of the largest remaining evergreen forest areas in north-eastern Vietnam (Fig. 5). Such forest type has been extensively cleared from areas of Vietnam east of the Red River. Therefore, Yen Tu may host a biodiversity that is no longer found elsewhere in the country. The Nature Reserve is located on the ridge of mountains, with the 1,068 m high Mount Yen Tu being

FIGURE 5: *Shinisaurus* habitat in Yen Tu Nature Reserve, Quang Ninh Province, north-eastern Vietnam. All photographs: Le Khac Quyet.

TABLE 1: Measurements (in mm) of the three voucher specimens of *Shinisaurus crocodilurus* from Vietnam.

	VNUH 19.5.'02-1	VNUH 19.5.'02-2	VNUH 19.5.'02-3
SVL	160.5	152.5	150.0
TaL	210.0	197.0	171.0
TL	370.5	349.5	321.0
HL	33.5	31.6	31.0
HW	22.9	22.1	22.8

the highest point. Streams originating on the northern face of the ridge flow in northern direction, while streams originating on the southern face flow south (for further information, see http://www.wing-wbsj.or.jp/~vietnam/source_book/nor_eas.htm).

The *Shinisaurus* population was discovered on 19 May 2002 in a height of ca. 600-800 m above mean sea level. During the day, between 11-13 h, at least 15 specimens were detected by the first author in an area of about 1 km². The lizards were found resting on branches near water on stream banks and feeding on earthworm-like invertebrates was observed. Once disturbed, they jumped into the water, where they remained submerged for up to 15 min. Three specimens were captured by hand from the stream. For measurements of these vouchers, which are currently deposited in the Vietnam National University, Hanoi (VNUH 19.5.'02-1, VNUH 19.5.'02-2, and VNUH 19.5.'02-3), as well as for their overall morphology and colouration pattern, we refer to Figs. 1-3 and Table 1. Locals denied having seen *Shinisaurus* outside of Yen Tu Nature Reserve. In the local (Dao) language, the species is called 'Cam cam'.

Illegal logging appears to be a major threat to the Yen Tu Reserve (Vietnam News, 2000). Further serious threats are hunting and trading. Although we recorded no reports of locals consuming the species, specimens are sold to tourists as "baby crocodiles" for 100,000 to 200,000 Vietnamese Dong (VND), corresponding to about 7-15 US Dollar. Yen Tu is a popular site for tourism, receiving up to two million visitors annually, among them domestic tourists from Hanoi and Hai Phong. To proceed with conservation activities further studies are urgently required for the Vietnamese population(s), focusing on population size estimates, distribution, habitat requirements and natural history. However, even for the previously known Chinese populations, aspects such as population size and the exact distribution of the species remain unknown due to habitat inaccessibility (Mägdefrau, 1997). This makes conservation measures and habitat management proposals more difficult to enforce (Zhang, 1987; Fu, 1991).

Further taxonomic work is desirable in the future, as the Vietnamese *Shinisaurus*, although superficially similar to the Chinese populations, were discovered about 500 km from the nearest population in China (see Fig. 4).

Our aim has been to highlight the importance of biodiversity research and conservation in Vietnam and its bordering areas. Currently, *Shinisaurus crocodilurus* is listed on CITES Appendix II. According to Mägdefrau (1997), the export of Chinese *Shinisaurus crocodilurus* drastically dropped since its inclusion in CITES Appendix II in 1990. At that time, China's population size of this species was estimated to represent about 2,500 animals, thus being less than the half of the 5,500 individuals estimated 13 years before (Zhang, 1991). Although further field studies are required in Yen Tu Nature Reserve and adjacent areas, we propose, as a first step, to include the species into the Red Data Book of Vietnam's animals.

ACKNOWLEDGEMENTS

We thank Vu Ngoc Thanh (Hanoi University of Science - Vietnam National University) and Vern Weitzel (United Nations Development Programme, Hanoi) for their support, Wolfgang Böhme (Zoologisches Forschungsinstitut und Museum A. Koenig, ZFMK, Bonn) and Rafe Brown, (University of Texas at Austin) commented on drafts of the manuscript. Andreas Schmitz (ZFMK) helped scan the figures.

LITERATURE CITED

AHL, E. 1930. Beiträge zur Lurch- und Kriechtierfauna Kwangsi's. *Sitzungsberichte*

der Gesellschaft naturforschender Freunde vom 1. April 1930, Berlin: 329-331.

BOBROV, V. V. 1995. Checklist and bibliography of the lizards of Vietnam. *Smithsonian Herpetol. Inf. Serv.* (105): 1-28.

BÖHME, W. 1988. Zur Genitalmorphologie der Sauria: funktionelle und stammesgeschichtliche Aspekte. *Bonn. Zool. Monogr.* 27: 1-176.

BOURRET, R. unpubl. Les lézards de l'Indochine. Unpublished manuscript, original in the "Institute of Ecology and Biological Resources", Hanoi. 218 pp.

DEPARTMENT OF ZOOLOGY, IEBR. 2000. [Survey of the fauna (mammals, birds, reptiles and amphibians) of Yen Tu mountain]. Institute of Ecology and Biological Resources, Hanoi. [In Vietnamese]

FAN, T. H. 1931. Preliminary report of reptiles from Yaoshan, Kwangsi, China. *Bull. Depart. Biol.*, *Coll. Sci., Sun Yatsen University, Canton* 11: 1-154.

FU, J. 1991. [A preliminary investigation of the habitat of Chinese crocodilian lizard (*Shinisaurus crocodilurus* Ahl), and the conservation strategy]. Scientific Treatise on Systematic and Evolutionary Zoology, China Publishing House of Science and Technology, Beijing 1: 41-47. [In Chinese.]

GOOD, D. A., A. M. BAUER & R. GÜNTHER. 1993. An annotated type catalogue of the anguimorph lizards (Squamata: Anguidae, Helodermatidae, Varanidae, Xenosauridae) in the Zoological Museum, Berlin. *Mitt. Zool. Mus. Berlin* 69(1): 45-56.

GRITIS, P. 1990. Observations on the lizard *Shinisaurus crocodilurus* in captivity. *Herpetol. Rev.* 21(4): 81-83.

GRYCHTA, U. 1993. *Shinisaurus crocodilurus* Ahl, 1930- Haltung, Ernährung, Geburt und neue Erkenntnisse über die Krokodilschwanzhöckerechse. *Sauria*, *Berlin* 15(1): 9-10.

HARVEY, M. B. 1993. Microstructure, ontogeny and evolution of scale surfaces in xenosaurid lizards. *J. Morphol.* 216(2): 161-177.

HERMANN, W., M. HOFFMANN & U. GRATZ. 1999. Chronologischer Abriss der Haltung, Zucht und Aufzucht von Krokodilschwanz-Höckerechsen (*Shinisaurus crocodilurus*) im Zoo Dresden. *Zool. Garten* 69(2): 126-132.

HU, Q., Y. JIANG & E. ZHAO. 1984. [A study on taxonomic status of *Shinisaurus crocodilurus*]. *Acta Herpetol. Sinica, Chengdu* 3(1): 1-7. [In Chinese.]

HUANG, Q. 1983. [A preliminary observation on ovoviviparous habit of *Shinisaurus crocodilurus* in captivity]. *Acta Herpetologica Sinica*, *Chengdu* n. s. 2(2): 77-79. [In Chinese.]

________. 1992. [The anatomy of the muscular systems of *Shinisaurus crocodilurus* (Lacertilia: Shinisauridae)]. *In*: Collected papers on herpetology. pp: 47-66. Y. Jiang (Ed). Sichuan Publ. House of Science and Technology, Chengdu. 157 pp. [In Chinese.]

KUDRJAWTSEW, S. W. & D. B. WASILJEW. 1991. Haltung und Zucht der Krokodilschwanz-Höckerechse *Shinisaurus crocodilurus* Ahl, 1930 im Moskauer Zoo. *Salamandra* 27(3): 219-221.

KUDRYAVTSEV, S. V. & D. B. VASSILYEV. 1998. Reproduction of *Shinisaurus crocodilurus* Ahl, 1930 at the Moscow Zoo. *Russian J. Herpetol.* 5(1): 15-16.

LAURENS, B. 1986. De krokodilhagedis *Shinisaurus crocodilurus*. *Aquarium*, *Den Haag* 56(3): 65-66.

LIU, X., F. ZHOU & G. PAN. 1989. [New discovery of localities of *Shinisaurus crocodilurus* Ahl]. *Sichuan J. Zool.* 8(3): 32-33. [In Chinese.]

MACEY, J. R., J. A. SCHULTE, II, A. LARSON, B. S. TUNIYEV, N. ORLOV & T. J. PAPENFUSS. 1999. Molecular phylogenetics, tRNA evolution, and historical biogeography in anguid lizards and related taxonomic families. *Mol. Phylogen. & Evol.* 12(3): 250-272.

MÄGDEFRAU, H. 1987. Zur Situation der Chinesischen Krokodilschwanz-Höckerechse, *Shinisaurus crocodilurus* Ahl, 1930. *Herpetofauna*, *Weinstadt* 9(51): 6-11.

________. 1997. Biologie, Haltung und Zucht der Krokodilschwanz-Höckerechse

(*Shinisaurus crocodilurus*). *Zeitschrift des Kölner Zoo* 40(2): 55-60.

________& B. SCHILDGER. 1993. Neues von *Shinisaurus crocodilurus* Ahl, 1930. *Herpetofauna*, *Weinstadt* 15(87): 11-16.

McDOWELL, S. B. JR & C. M. BOGERT. 1954. The systematic position of *Lanthanotus* and the affinities of the anguimorphan lizards. *Bull. American Mus. nat. Hist.* 105(1): 1-142.

NGUYEN, V. S. & T. C. HO. 1996. Danh luc bo sat va ech nhai Viet Nam [Amphibians and reptiles of Vietnam]. Nha xuat ban khoa hoc va ky thuat, Hanoi. 264 pp. [In Vietnamese.]

________, Q. T. NGUYEN & T. S. NGUYEN. 2000. [Preliminary results of the survey on herpetofauna in Yen Tu mountain area]. *Tap Chi Sinh Hoc* [*Journal of Biology*] 22(15)CD: 11-14. [In Vietnamese.]

RIEPPEL, O. 1980. The phylogeny of anguinomorph lizards. *Denkschr. Schweiz. naturf. Ges.* 94: 1-86.

ROGNER, M. 2002. Krokodilschwanz-Höcherechse. *Das Aquarium* 400: 67-72.

SHEN, L. & H. LI. 1982. [Notes on the distribution and habits of the lizard *Shinisaurus crocodilurus* Ahl]. *Acta Herpetol. Sinica*, *Chengdu* n. s. 1(1): 84-85. [In Chinese; translated by D.-T. Yang. 1987. *Bull. Chicago Herpetol. Soc*. 22(1): 4-5.]

SPRACKLAND, R. G. 1989a. An enigmatic dragon brought to light, the Chinese crocodile lizard in captivity, *Shinisaurus crocodilurus*. *Vivarium*, *Lakeside* 2(2): 12-14.

________. 1989b. The Chinese crocodile lizard. *Trop. Fish Hobbyist* 38(2): 102-109.

________. 1992. The biology of the Chinese crocodile lizard in captivity. 1991 NCHS Captive propagation and husbandry conference: 45-54.

TANG, Z. 1986. [Indoor propagation of *Shinisaurus crocodilurus* and observation on the growth of the young]. *Chinese J. Zool.*, *Beijing* 21(4): 10-12. [In Chinese.]

THATCHER, T. 1990. The Chinese crocodile lizard, *Shinisaurus crocodilurus*, notes on captive births and husbandry. *British Herpetol. Soc. Bull.* (33): 17-19.

TOKYO ZOOLOGICAL PARK SOCIETY. 1987. Zoo news, animal and zoos. Tokyo Zoological Park Society, Tokyo 12: 44.

UNDERWOOD, G. 1957. *Lanthanotus* and the anguinomorphan lizards: a critical review. *Copeia* 1957(1): 20-30.

VIETNAM NEWS. 2000. Yen Tu forest destroyed. *Vietnam News*, 15 July.

VISSER, G. J. 1989a. Chinese crocodile lizards *Shinisaurus crocodilurus* in Rotterdam Zoo. *Int. Zoo Yrbk.* 28: 136-139.

________. 1989b. *Shinisaurus crocodilurus* in Blijdorp Zoo. *Lacerta* 47(4): 98-105.

WERMUTH, H. 1958. Die Krokodilschwanz-Höckerechse, *Shinisaurus crocodilurus* Ahl. *Aquar. Terr. Zeitschrift* 5(3): 4.

________. 1985. Who is who: Die Krokodilschwanz-Höckerechse (*Shinisaurus crocodilurus*). *Aquar. Terr. Zeitschrift* 38(5): 235-236. [English translation by P. Gritis, 1987, *Bull. Chic. Herpetol. Soc.* 22(1): 7-8]

WILKE, H. 1985a. Eingewöhnung, Haltung und Geburt der seltenen Krokodilschwanz-Höckerechsen *Shinisaurus crocodilurus*. *Sauria*, *Berlin* 7(1): 3-4.

________. 1985b. Eingewöhnung, Haltung und Geburt der seltenen Krokodilschwanz-Höckerechsen *Shinisaurus crocodilurus* Ahl, 1930. "*Vivarium Darmstadt*" 1: 265.

________. 1985c. Erfolgreiche Eingewöhnung von seltenen Krokodilschwanz-Höckerechsen im Vivarium, Darmstadts Tiergarten, gelungen. *Herpetofauna*, *Weinstadt* 7(34): 30.

________. 1986. Eingewöhnung, Haltung und Geburt der seltenen Krokodilschwanz-Höckerechsen, *Shinisaurus crocodilurus*. *DGHT Rundbrief* 88: 12-13.

ZHANG, F. 1986. [Studies on morphological characters of hemipenes of the Chinese lizards]. *Acta Herpetol. Sinica*, *Chengdu* n. s. 5(4): 254-259. [In Chinese.]

ZHANG, Y. 1981. [Ecological observations on *Shinisaurus crocodilurus* on Mt. Yao, Guangxi]. *Chinese J. Zool., Beijing* 16(4): 12-14. [In Chinese.]

________. 1985. [The biology of *Shinisaurus crocodilurus*]. *Acta Herpetol.*

Sinica, Chengdu n. s. 4(4): 337-340. [In Chinese.]

________. 1986. [*Shinisaurus crocodilurus* - An endangered animal]. *Chinese J. Zoology*, *Beijing* 21(5): 38-39. [In Chinese.]

________. 1987. [The perilous status of *Shinisaurus crocodilurus* in Yaoshan and its protection]. *Nature*, *Beijing* 1987(4): 18-19. [In Chinese.]

________. 1988. [*Shinisaurus crocodilurus* in Yao Shao]. *Chinese Wildlife* 3: 12-13. [In Chinese.]

________. 1991. [The Chinese crocodilian lizard]. China Forestry Publ. House, Beijing. 97 pp. [In Chinese.]

ZHAO, E. & K. ADLER. 1993. Herpetology of China. Society for the Study of Amphibians and Reptiles: Contribution to Herpetology 10. 1-522.

ZIEGLER, T. 2002a. Die Amphibien und Reptilien eines Tieflandfeuchtwald-Schutzgebietes in Vietnam Natur & Tier Verlag, Münster. 342 pp.

________. 2002b. Herpetologisch Neues aus einem der letzten Tieflandfeuchtwälder Vietnams *Reptilia*, *Berlin* 7(3): 41-49.

________& W. BÖHME. 1997. Genitalstrukturen und Paarungsbiologie bei squamaten Reptilien, speziell den Platynota, mit Bemerkungen zur Systematik. *Mertensiella* (8): 1-207.

________& H.-W. HERRMANN. 2002. Wiederentdeckung zweier gehörnter Grubenotterarten in Vietnam. *Mitteilungen Zoologische Gesellschaft für Arten- und Populationsschutz e.V.* 18(2): 24-26.

Received: 12 December 2002.
Accepted: 26 February 2003.

Hamadryad Vol. 27, No. 2, pp. 200 – 204, 2003.

DIET RECORDS FOR *CROCODYLUS CATAPHRACTUS* (REPTILIA: CROCODYLIDAE) AT LAKE DIVANGUI, OGOOUÉ-MARITIME PROVINCE, SOUTHWESTERN GABON

Olivier S. G. Pauwels[1], Victor Mamonekene[2], Pierre Dumont[3], William R. Branch[4], Marius Burger[5] and Sébastien Lavoué[6]

[1] Department of Recent Vertebrates, Institut Royal des Sciences naturelles de Belgique, Rue Vautier 29, 1000 Brussels, Belgium; Email: osgpauwels@hotmail.com

[2] Institut de Développement Rural, Université Marien Ngouabi, B.P. 69, Brazzaville, Republic of Congo; Email: mamonekene@hotmail.com

[3] Biologie des Eaux Douces, Institut Royal des Sciences naturelles de Belgique, Rue Vautier 29, 1000 Brussels, Belgium; Email: pierre.dumont@naturalsciences.be

[4] Department of Herpetology, Port Elizabeth Museum, P.O. Box 13147, Humewood 6013, South Africa; Email: bitis@telkomsa.net

[5] Life Sciences Division, South African Museum, P.O. Box 61, Cape Town 8000, South Africa; Email: marius@maths.uct.ac.za

[6] Ichtyologie générale et appliquée, Muséum National d'Histoire Naturelle, 43 rue Cuvier, 75005 Paris, France; Email: lavoue@mnhn.fr

ABSTRACT.– A population of *Crocodylus cataphractus* was discovered at Lake Divangui, south-western Gabon. Data on stomach contents (fish and gastroliths) of this species are provided. A first, very preliminary list of fish species inhabiting the lake includes 10 species (1 Characidae, 2 Aplocheilidae, 1 Claroteidae, 3 Cichlidae, 1 Distichodontidae, 1 Clariidae, and 1 Hepsetidae).

KEYWORDS.– Reptilia, *Crocodylus cataphractus*, Pisces, diet, gastrolith, Lac Divangui, Ogooué-Maritime, Gabon.

INTRODUCTION

Lake Divangui is situated in Ogooué-Maritime Province, south-western Gabon. It belongs to the Echira River system to which it is connected through a small stream. Its diameter is ca. 1 km, its altitude 22 m a.s.l. The depth is ca. 80 m, which makes it the deepest lake of Gabon. It has a peculiar geological history, and is probably the surface expression of a salt diapir which was eroded about 300,000 years before present (Anselmetti et al., 1997, 1999; Ariztegui et al., 1998, 1999). The surrounding human population density is low, although there is limited subsistence fishing activity. In the course of an aquatic vertebrate survey as part of the Gamba Complex Biodiversity Project (Smithsonian Institution/Shell Gabon), we made preliminary investigations on the fish and herpetofauna of the lake. In the present report, which constitutes the first zoological study ever provided for this lake, we report observations on the diet of the slender-snouted crocodile, *Crocodylus cataphractus* Cuvier, 1825 collected with nets by fishermen in the lake, as well as a very preliminary list of fish species for the lake.

MATERIAL AND METHODS

The survey was undertaken during the dry season (20-21 July 2002), and focused on the western bank of the lake (GPS coordinates 01° 56' 28.4''S, 09° 59' 19.9''E). Fishes were caught with nets and by angling, using locally collected earthworms as bait. On the first morning, we examined six drowned specimens of *Crocodylus cataphractus* accidentally caught by local fishermen's nets designed to catch fish. The two nets were about 30 m long by 2 m high, suspended by floats, and placed a few meters from, and perpendicularly to, the bank. The whole crocodile stomach contents were extracted and transferred to

TABLE 1: Description of the gastroliths sets found in three *Crocodylus cataphractus* stomachs at Lake Divangui, south-western Gabon.

Crocodile n°	Crocodile total length (cm)	Number of gastroliths	Nature of gastroliths	Total dry weight of gastroliths (g)	Mean weight of gastroliths (g)	Maximal diameter of smallest gastrolith (mm)	Maximal diameter of largest gastrolith (mm)
2	216	38	Limonite	44.99	1.18 ± 1.23	3.1	34.1
3	212	17	Limonite + quartz	30.45	1.79 ± 1.28	2.5	27.0
6	201	34	Limonite	58.63	1.72 ± 1.75	5.0	29.6

10% formalin until identification the following day. Stomach contents were not preserved, but voucher specimens for the fish species that we caught in the lake will be deposited in the collections of the Muséum National d'Histoire Naturelle in Paris, the Smithsonian Institution in Washington, D.C., the Smithsonian Institution Biodiversity Center in Gamba, and the Institut Royal des Sciences Naturelles de Belgique in Brussels. The dry weight of the gastroliths was obtained with a Ohaus Adventurer balance (precision 10^{-3}g) after the gastroliths had been washed through a 200 microns Retsch screen, and dried in a W.C. Heraeus Hanau oven at 110° C for 28 h and then cooled to 20° C in a dessicator with synthesis gel. The size of gastroliths was measured with a Tajima Dial-15 caliper (precision 0.1 mm).

RESULTS

Local people claim that the density of crocodiles in the lake is extremely high. A five minutes overview from a single point of the lake bank (01° 56' 28.4''S, 09° 59' 19.9''E) with binoculars on 20 July 2002 at 17.30 h allowed us to detect five individuals of *Crocodylus cataphractus* swimming at the surface of the lake; another visual survey on 21 July at 11.00 h revealed 24 active specimens. Because of the vegetation along the banks, only a small part of the lake was in view. The six crocodiles drowned in the fishermen nets measured respectively (snout-vent length + tail length, in cm), from the longest to the shortest, 137 + 96, 126 + 90, 123 + 89, 119 + 85, 117 + 84, and 115 + 86. The stomach of the largest contained nothing but a few gastroliths (not collected). The five others had eaten, respectively: 1 *Chrysichthys* sp. (Claroteidae); 2 *Distichodus notospilus* Günther, 1867 (Distichodontidae) + 1 *Chrysichthys* sp.; 1 Cichlidae sp.; 1 Cichlidae sp. + 1 *Tilapia* sp. (Cichlidae) + 3 *Nannopetersius ansorgii* (Boulenger, 1910) (Characidae); and 1 *Tilapia rendalli* (Boulenger, 1897) (Cichlidae). No nematodes or other macroscopic parasites were detected in the stomachs nor in the abdominal cavity, and all crocodiles seemed very healthy. The gastroliths of three of the crocodiles were studied (see Table 1). All gastroliths are composed of limonite, except one (weight 3.50 g, maximum diameter 18.8 mm) in crocodile 3 which is a quartz.

The fish species collected in the lake include: *Nannopetersius ansorgii* (Characidae), *Aphyosemion* sp. and *Epiplatys sexfasciatus* Gill, 1862 (Aplocheilidae), *Chrysichthys auratus* (Geoffroy Saint-Hilaire, 1808-1809) (Claroteidae), *Oreochromis schwebischi* (Sauvage, 1884), *Tilapia cabrae* Boulenger, 1899 and *Tilapia rendalli* (Boulenger, 1897) (Cichlidae), *Distichodus notospilus* Günther, 1867 (Distichodontidae), *Clarias* sp. (Clariidae) and *Hepsetus odoe* (Bloch, 1794) (Hepsetidae). The *Chrysichthys* sp. found in the crocodiles stomachs may be *C. auratus*, but their partly digested condition prevented positive identification.

DISCUSSION

Crocodylus cataphractus has previously been recorded from the Gamba Complex (Bourobou Bourobou, 1999: 12; Camara Gakou, 1992: 23). Blaney et al. (1997: 43) mentioned that the species is collected by nets in the Gamba Complex, Canton Basse Nyanga; the same authors observed the species in the "rivière Mougouambi,

tronçon Mayonami-Moulondo"(loc. cit.: 67) and provided a unambiguous picture of a specimen collected by net at Mbouda. Outside of the Gamba Complex, *C. cataphractus* occurs in several protected areas of Gabon, notably that of Ipassa, Ogooué-Ivindo Province (Steel, 1994: 4), and Lopé-Okanda Reserve (Blanc and Frétey, 2000). Human predation on *C. cataphractus* in Gabon is widespread and heavy, and has been reported from Moyen-Ogooué Province, Ogooué-Ivindo Province and Ogooué-Lolo Province (Abercrombie, 1978; Gramentz, 1999; Knoepffler, 1974; Pauwels et al., 2002). Steel (1994: 39) moreover reported the species as being sold as food on the Port Gentil markets. The species is easily caught and drowned by fishnets (Lawson, 1993; Fleury and Gautier, unpubl. obs.; present obs.) and is hence especially vulnerable. Due to intensive hunting in Gabon and adjacent countries, the species is listed in CITES Appendix 1. Despite this very few studies have been made on its biology, which remains poorly known (Spawls et al., 2002).

Fishermen in Diangui, Ogooué-Lolo Province, reported that the aquatic colubrid snake *Grayia ornata* was part of the diet of *Crocodylus cataphractus* (Pauwels et al., 2002: 138). Lang *in:* Schmidt (1919) recorded a wide range of prey in the stomachs of Congo *C. cataphractus*: "shrimps (Palaemonidae), crabs (Thelphusidae), batrachians, water-snakes, fish and even grasshoppers had been eaten by young". However, no specific details or identifications were given. In support to the food eclecticism of *C. cataphractus*, we here report observations made by Fleury and Gautier (pers. comm., Dec. 2002) at the Station de Recherche de la Makandé (00° 40' 54''S, 11° 54' 42''E) in the Forêt des Abeilles (Lopé Department, Ogooué-Ivindo Province, Gabon), on the stomach contents of a specimen found drowned in a fisherman's net on 6 August 1995. The crocodile's total length was 256 cm (SVL 142 cm), its weight 52.5 kg. Its stomach contained the remains of a young Water Chevrotain (Artiodactyla: Tragulidae: *Hyemoschus aquaticus*) consisting of the legs, omoplates, three hooves, bones, and a 2396 sq. cm fragment of skin. At that place, the depth of the Makandé River was about 60 to 80 cm.

Although their predation range is certainly much wider, our observations on the crocodiles stomach contents at Lake Divangui allow us to conclude that they prey on at least five fish taxa, of which three could be identified at the specific level. Among the other fish species that we recorded from the lake, several probably enter in the crocodiles diet, as well as other yet unrecorded species. Considering their lengths, the crocodiles examined by us were all subadults or adults; the diet of juveniles must include much smaller prey.

Limonite and quartz are naturally present in environments like a tropical African lake (Deliens, pers. comm. Sept. 2002). All the presently studied gastroliths have an irregular but smooth surface, maybe because they have been brought to the lake by a stream. The role of gastroliths has currently not yet been elucidated (see for example the recent work of Platt et al., 2002), but the prevalent hypotheses are that they could help in the digestion by an easier breakdown of the ingested prey, or may serve as ballast for buoyancy control. As the weight of the gastrolith sets in each stomach was between 30 and 60 gm (Table 1) and we estimated these crocodiles to weigh around 40 kg each, it seems unlikely that the gastroliths can exert any significant effect on buoyancy. Our specimens were completely devoided of visible parasites, and it is possible, as suggested by Lang *in:* Schmidt (1919: 430), that the gastroliths play a role in this. The present gastroliths have been deposited in collections (IRSNB 16626-8, from crocodiles 2, 3, 6 respectively) and remain available for further studies.

CONCLUSIONS

These new records constitute an important contribution to knowledge of the diet of *Crocodylus cataphractus*, for which little biological data are available. It allows a better understanding of its importance in the local trophic chain. It is evident that the population of *C. cataphractus* in Lake Divangui remains large. Due to its remoteness and the low human density and predation pres-

sure, the lake could form an important protected sanctuary for this endangered species. Additional studies on this peculiar and remote lake are required. Due to its great depth and unique geological history it may harbour possible fish endemics. The herpetofauna is also poorly studied, and the presence of chelonians, including trionychids and pelomedusids, as well as aquatic snakes requires confirmation. Their presence would enhance the value of the lake for conservation.

ACKNOWLEDGEMENTS

This research was supported by the Smithsonian Institution (SI)/Monitoring and Assessment of Biodiversity Program (MAB) and grants from Shell Foundation and Shell Gabon. This publication is contribution 19 of the Gabon MAB Program. We are grateful to Michelle Lee, Francisco Dallmeier and Alfonso Alonso (SI), Frank Denelle, Jean-Pierre Tallon, Faustin Bangole, Robert Armbrust, G. Brown, Frank Jolin and Stanley Kennard (Shell-Gabon), Jean-René Derche and the Sodexho team at Rabi-Didjombi, and Noël Paquin (SGS-Rabi) for logistic support, and to J. E. Mackayah Mboumbouh (Sette Cama) and A. Tsandi (Gamba) for their technical help. Thanks are due to Michel Deliens (Mineralogy Section, IRSNB) for the geological identification of the gastroliths. We warmly thank Emile Mamfoumbi Kombila and Adrien Noungou (Direction de la Faune et de la Chasse, Libreville) for research permits, and Jose Luis Bonnin and Anthony Brenon (CBG-Rabi) for help in the fieldwork. OSGP thanks Georges Coulon and Georges Lenglet (IRSNB) for working facilities. Sally Lahm (Makokou), Marie-Claire Fleury (Haut-Niger National Park), Daniel Ariztegui (Geological Institute, ETH, Zürich), Jean-Pierre Gautier (Université de Rennes), and André Kamdem Toham and Rufin Mikala Mussavu (WWF-CARPO, Libreville) kindly provided literature references or unpublished data. Thanks also to Perran Ross (Crocodile Specialist Group) for reviewing the manuscript.

LITERATURE CITED

ABERCROMBIE, C. L. 1978. Notes on West African crocodilians (Reptilia, Crocodilia). *J. Herpetol.* 12(2): 260-262.

ANSELMETTI, F. S., D. ARIZTEGUI, J. MALEY, R. OSLISLY & M. FONTUGNE. 1999. Linking palaeoenvironmental changes and human settlement history in Equatorial rainforest: evidence from the sedimentary record of lakes Divangui and Kamalété, Gabon. *In*: INQUA XV International Congress, Durban, South Africa, 3-11 Aug. 1999. p. 9.

________,_________,G. von Salis, J. Maley & R. Oslisly. 1997. The Lac Divangui (Gabon) Sedimentary Record: reconstructing tropical environmental changes in Equatorial Africa. p. 51. *In*: American Geophysical Union Annual Meeting, San Francisco, U.S.A., 8-12 Dec. 1997. *Trans. AGU* 78 (46).

ARIZTEGUI, D., F. S. ANSELMETTI, R. OSLISLY, J. MALEY & M. FONTUGNE. 1999. Linking palaeoenvironmental changes and human settlement history in Equatorial rainforest: Evidence from the sedimentary record of lakes Divangui and Kamalété, Gabon. *In*: Abstracts. COL Symposium "Looking into the sediment subsurfaces of lakes", Zürich. 7-8 Oct. 1999. pp: 3-4.

________,_________,G. von Salis, J. Maley & R. Oslisly. 1998. Paleoenvironmental changes in African Equatorial rainforest: the Lac Divangui (Gabon) Sedimentary Record. *In*: Abstracts. "Past global changes and their significance for the future", IGBP PAGES Open Science Meeting, London. p. 40.

BLANC, C. P. & T. FRÉTEY. 2000. Les reptiles de la Réserve de Faune de la Lopé et de la Forêt des Abeilles (Gabon). *Bull. Soc. Zool., France* 125(4): 281-292.

BLANEY, S., S. MBOUITY, J.-M. NKOMBÉ & M. THIBAULT. 1997. Complexe d'Aires Protégées de Gamba. Caractéristiques socio-économiques des populations des départements de la Basse-Banio et de la Mougoutsi (Mouenda). Unpublished report presented to the "WWF-Programme pour le Gabon", Libreville. i-vi + 1-75 + annexes + map + plates.

BOUROBOU BOUROBOU, H. P. 1999. Gamba entre la réserve et les intérêts des populations autochtones. Projet sur la Biodiversité dans le Développement, IRET/CENAREST, Libreville. 1-21 + figs.

CAMARA GAKOU, F. 1992. Project [sic] de programme d'éducation et de formation à l'environnement des ruraux au Gabon. Unpublished report presented to the "WWF - Programme pour le Gabon", Libreville. 33 pp.

GRAMENTZ, D. 1999. Schwere Zeiten für Reptilien in Gabun. *Elaphe* 7(2): 57-61.

KNOEPFFLER, L.-P. 1974. Faune du Gabon (Amphibiens et Reptiles). II. - Crocodiles, chéloniens et sauriens de l'Ogooué-Ivindo et du Woleu N'tem. *Vie Milieu* 24(1), ser. C: 111-128.

LAWSON, D. P. 1993. The reptiles and amphibians of the Korup National Park Project, Cameroon. *Herpetol. nat. Hist.* 1(2): 27-90.

PAUWELS, O. S. G., A. KAMDEM TOHAM & C. CHIMSUNCHART. 2002. Recherches sur l'herpétofaune du Massif du Chaillu, Gabon. *Bull. l'Inst. Royal Sci. nat. Belgique*, *Biol.* 72: 47-57.

________, ________ & V. Mamonekene. 2002. Ethnozoology of the *Dibomina* (Serpentes: Colubridae: *Grayia ornata*) in the Massif du Chaillu, Gabon. *Hamadryad* 27(1): 136-141.

PLATT, S. G., T. R. RAINWATER & S. T. McMURRY. 2002. Diet, gastrolith acquisition and initiation of feeding among hatchling Morelet's crocodiles in Belize. *Herpetol. J*. 12: 81-84.

SCHMIDT, K. P. 1919. Contributions to the herpetology of the Belgian Congo based on the collection of the American Museum Congo Expedition, 1909-1915. Part I. Turtles, crocodiles, lizards, and chameleons. *Bull. American Mus. nat. Hist.* 39: 385-624.

SPAWLS, S., K. HOWELL, R. DREWES & J. ASHE. 2002. A field guide to the reptiles of East Africa. Academic Press, London & San Diego. 543 pp.

STEEL, E. A. 1994. Etude sur le volume et la valeur du commerce de la viande de brousse au Gabon. Unpublished report presented to the "WWF - Programme pour le Gabon", Libreville. i-v + 1-84 pp.

Received: 31 January 2003.
Accepted: 18 February 2003.

Hamadryad Vol. 27, No. 2, pp. 205 – 213, 2003.

ON THE STATUS OF THE NAME *OLIGODON TAENIOLATUS* (JERDON, 1853) AND ITS LONG-IGNORED SENIOR SYNONYM AND SECONDARY HOMONYM, *OLIGODON TAENIOLATUS* (DAUDIN, 1803)

Aaron M. Bauer

Department of Biology, Villanova University, 800 Lancaster Avenue, Villanova, Pennsylvania 19085, U.S.A.
Email: aaron.bauer@villanova.edu

ABSTRACT.– The scientific name universally applied to the streaked kukri snake, *Oligodon taeniolatus* (Jerdon, 1853) is a junior synonym and secondary homonym of *O. taeniolatus* (Daudin, 1803), a name not cited as valid since its initial proposal. It is unclear, however, if Jerdon's use of the name, in the combination *Coronella taeniolata*, was intended as a description by the author, although it has been regarded as such by virtually all 20th century workers. In accordance with Article 23.9 of The International Code of Zoological Nomenclature, Jerdon's name should be regarded as a nomen protectum and has precedence over that of Daudin, which is a nomen oblitum.

KEYWORDS.– Nomenclature, *Oligodon taeniolatus*, Jerdon, Daudin.

INTRODUCTION

Oligodon taeniolatus, the streaked or variegated kukri snake, is a common colubrid snake of South Asia that ranges from eastern Pakistan to Bangladesh (Das, 1994; 1996). The first reference to this species in the herpetological literature is by Russell (1796) who recorded it as the "wanapa pam," based on its Telugu name (Das, 1998). Duméril et al. (1854) provided the scientific name *Oligodon subgriseus* for the species and this remained in consistent use for more than half a century (e.g., Günther, 1858, 1864; Beddome, 1862, 1863; Theobald, 1868; Nicholson, 1874; Ferguson, 1877; Blanford, 1879; Murray, 1886; Boulenger, 1890, 1894; Sclater, 1891a, 1891b; Cazaly, 1914; Wall, 1905, 1909, 1919). Wall (1909), however, noted that the description of *Coronella taeniolata* by Jerdon (1853) clearly referred to the same snake and suggested that this name should have priority over *O. subgriseus*. Although several modern authors (e.g., Hoge and Romano Hoge, 1981; Golay et al., 1993; McDiarmid et al.,1999; David and Ineich, 1999) have cited the actual date of Jerdon's publication as 1854, the original wrappers on the part of the journal containing this and other snake descriptions (Volume 22[VI] = issue CCXXXVII) are dated 1853 and in the absence of information to the contrary I accept this date as correct.

Although the specific epithet *taeniolatus* as proposed by Jerdon (1853) does indeed have temporal priority over *subgriseus*, it is not the oldest name available for the streaked kukri snake. Russell's "wanapa pam" first served as the basis for a formal description a full half century earlier (Daudin, 1803), although this name has subsequently been ignored by virtually all herpetologists. To confuse matters further, the senior synonym of *Oligodon taeniolatus* (Jerdon, 1853) is also a senior secondary homonym. In this paper I review the history of the Latin names that have been applied to the streaked kukri snake and propose a solution under the provisions of the International Code of Zoological Nomenclature to stabilize the correct name and authorship of the species.

NOMENCLATURAL HISTORY

Wall (1909) suggested that the snake known throughout the latter half of the 19th Century and into the early 1900s as *Oligodon subgriseus* (Duméril, Bibron and Duméril, 1854) had actually been described a year earlier by Jerdon

(1853). Jerdon (1853) provided the following account of the species:

"CORONELLA TÆNIOLATA — Russell 1, pl. 19?

15 rows of smooth scales; Scutæ 185. Scutellæ 41.

This species is referred to *Tropidonotus stolatus* by Cantor, but a snake that I possess and which answers tolerably well to Russell's description and figure appears to be a true Coronella. It is common at Madras."

Wall (1909, 1919), despite recognizing the temporal priority of Jerdon's name, did not abandon *subgriseus* in favour of *taeniolatus* until somewhat later (Wall, 1921, 1923a, 1923b). Virtually all subsequent authors have consistently followed Wall (1921) and have referred to this snake as *Oligodon taeniolatus* (Jerdon, 1853) (e.g., Fraser, 1937; Smith, 1943; Constable, 1949; Das, 1994, 1996, 1997; but see Thomas and Easa, 1997).

Wall and all subsequent authors apparently overlooked the fact that this snake had actually been described, using the same specific epithet, and with reference to the same illustration, exactly 50 years earlier by Daudin, whose detailed account of the snake (1803: 428-429) was derived entirely from the information provided by Russell (1796):

"LA COULEUVRE A BANDEROLES (1).

Les habitans du Bengale désigent sous le nom de *wanapa-pam*, selon Russel, une petite especies de couleuvre assez rare au Vizagapatam. Elle a cent quatre-vingt-deux grandes plaques sous le corps, et trente-huit doubles sous la queue.

La tête est à peine plus élargie que le cou, ovale-oblongue, obtuse, et couverte en dessus de neuf plaques; la bouche est fendue, large, avec sa mâchoire inférieure plus courte; les dents sont nombreuses, petites, un peu courbées et disposées sur les branches marginales et palatals.

Le corps est cylindrique, long, peu renflé vers son milieu, et couvert d'écailles lisses, ovales et imbriquées; le cou est gros comme le tuyau d'une plume d'oie, et le corps l'est comme te tuyau d'une plume de cygnet; la queue est très-courte, et fait la neuvième partied u total; elle est terminée en une pointe aiguë. La longueur de cette couleuvre est d'un pied deux pouces.

Entre les yeux il y a deux lignes noires, et l'on en voit une troisième entre les deux grandes plaques postérieures. La couleur dominante de ce reptile est d'un châtain clair, élégamment orné sur toute la longueur en dessus d'un blanc jaunâtre mélangé de points blancs; et sur les bords de chaque côté il y a deux lignes, l'une grise et l'autre baie; entre les filets gris sont des bandes transversals rapprochées, nombreuses, formées de petits traits obliques et noirs. Les plaques sont toutes d'un gris de perle, assez clair.

(1) *Coluber taeniolatus; suprà castaneus lineolis longitudinalibus albidis, cum fasciis transverses nigris et numerosis suprà dorsum; colore subtùs pallidè margaritaceo; caudâ* 1/9.

Scutis abdom. 182. — *Scutellis subcaud*. 38-220.

Wanapa-pam. Russel, Hist. nat. of Indian serpens, p. 24, n° 19, pl. XIX."

The reference to Russell's "wanapa pam" makes it clear that both Daudin (1803) and Jerdon (1853) were indicating the same species in their respective descriptions. One possible explanation for the homonymy is that Jerdon (1853) was aware of Daudin's name and was merely erecting a new combination in allocating the species to *Coronella*. On the one hand, this is supported by the fact that Jerdon did not follow the name by "n.s." as he did in the case of most of his descriptions of new taxa in the same paper. On the other hand, Jerdon (1853) typically cited the authors of existing names, whereas in the case of *C. taeniolata* there is no reference to Daudin, only to Russell. Daudin is, however, cited elsewhere in Jerdon's (1853) paper (e.g., in the accounts of *Hydrus schistosus*, *Hydrus nigrocinctus*, *Typhlops braminus* and *Coluber pictus*), suggesting that he had access to the work, or was aware of its contents. This ambiguity is compounded by a later statement by Jerdon (1870): "I believe the figure of Russell 1, pl. 19, which has been called *Col. taeniolotus* [sic!], but generally referred to the young of *Tripidonotus* [sic!] *stolatus*, refers to a species of *Oligodon*. . . . Whether this snake can be referred to one of the lately described species or not, it must (in case

my observations are verified) stand as *Oligodon taeniolatum*." Jerdon here mentions "*Col*[*uber*] *taeniolatus*," but does not cite Daudin (1803) explicitly. Oddly, he does not mention his own use of *Coronella taeniolata* at all. Indeed, it appears as if Jerdon (1870) either did not recall his own 1853 description of *Coronella taeniolata,* or that he considered *Oligodon taeniolatum* and *Coronella taeniolata* each to be valid taxa belonging to different genera, despite the association of both with the "wanapa pam." As unlikely as these alternatives may seem, there is certainly precedence for authors describing the same specimen as the type of multiple new taxa (e.g., J. E. Gray). Unfortunately, it is not possible to determine with certainty if, in fact, Jerdon (1853, 1870) himself followed Daudin in using the epithet *taeniolata* (*-um*), or intended to coin a new name. However, it is clear that subsequent authors have uniformly accepted Jerdon's name as new. For example, Das et al. (1998), based on Jerdon's (1853) statement "it is common at Madras," considered that a type from Madras had once existed, but could not locate it in the collection of the Zoological Survey of India. [In fact, if Jerdon's use of the name was intended as a description, the specimen figured by Russell (1796: pl. 19) would be one of the syntypes thereof. A second specimen, with the ventral and subcaudal counts noted by Jerdon (185 and 41) would constitute a second syntype. Although Madras is the only locality cited by Jerdon, there is no statement explicitly linking the second putative syntype to this locality].

Regardless of Jerdon's intentions, it is interesting how completely awareness of *Coluber taeniolatus* Daudin, 1803 appears to have faded in the literature. Although Daudin's Histoire Naturelle, Générale et Particulière des Reptiles (1801-1803) was a standard systematic reference that served as the primary review of the world's herpetofauna until the publication of the Erpétologie Générale by Duméril and Bibron, this particular name appears to have gone unnoticed by most subsequent workers (e.g., Fitzinger, 1826; Boie, 1827; Wagler, 1830; Schlegel, 1837). Merrem (1820), one of the few authors to note the name, explicitly mentioned the "wanapa pam" and *Coluber taeniolatus* in his synonymy of *Coluber sibilans* (now *Psammophis sibilans*), along with *C. gemmatus* Shaw, 1802, which is itself probably referable to *Psammophis schokari* (Forsskål, 1775 ; fide Smith and David, 1999). Cantor (1847) subsequently placed both Russell's "wanapa pam" and *C. taeniolatus* Daudin, 1803 in the synonymy of *Tropidonotus stolatus* (now *Amphiesma stolata*), although both Russell (1796) and Daudin (1803) listed numerous features, such as smooth dorsal scales, that are clearly not compatible with *A. stolata.* As noted above, Jerdon (1853) recognized Cantor's (1847) error in synonymizing the *wanapa pam* with *A. stolata*, but made no mention of Daudin's name when proposing his own. Duméril et al. (1854) in their account of *Amphiesma stolatum* cited Russell's (1796) "wanna pam" (pl. 10) and "wanna cogli" (pl. 11) in synonymy, but like Jerdon (1853) excluded the "wanapa pam" (pl. 19). Indeed, I was unable to locate any mention of the "wanapa pam" or *Coluber taeniolatus* Daudin, 1803 by Duméril et al. (1854).

Günther (1858, 1864) likewise ignored both Daudin's name and Russell's (1796) plate of the "wanapa pam," although he referred other of Russell's plates, including those cited by Duméril et al., as well as plate 19 from Russell's (1801-1810) later work, to the synonymy of *Amphiesma stolata*. Günther (1858, 1864) also appears to have overlooked *Coronella taeniolata* Jerdon, 1853, contributing to its obscurity until its "rediscovery" by Wall (1909). Jerdon's (1870) subsequent mention of *Col*[*uber*] *taeniolatus,* arguably a reference to Daudin, 1803 (see comments above) was likewise ignored by later workers and the name sank into complete obscurity, as reflected by its omission (along with Jerdon's use of the names *Coronella taeniolata* and *Oligodon taeniolatum*) by Boulenger (1890, 1894). It is probable that the absence of Daudin's name in these standard references, particularly Boulenger's (1894) Catalogue of the Snakes, resulted in its near permanent "loss," as it is evident that most subsequent authors have relied on this monumental work as their guide to the older literature and

rarely consulted the early 19th century classics themselves.

The only 20th century mentions of the name *Coluber taeniolatus* in any context are its inclusion (with correct attribution to Daudin, 1803) in Sherborn's (1931) Index Animalium and its listing (as an unidentifiable species) by Ulber (1996) in the index to a facsimile edition of Gray's (1831) A Synopsis of the Species of the Class Reptilia. Gray (1831) had indeed cited the name *C. taeniolatus*, crediting it to Boie (no date), although I was unable to locate such a reference in the major published papers of either M. Boie (Boie in Schlegel, 1826) or F. Boie (1827) or in any other works by these authors.

AUTHORSHIP OF *OLIGODON TAENIOLATUS*

If one accepts the premise that Jerdon's (1853) use of the name *Coronella taeniolata* constitutes an intended description, then it is evident that *Oligodon taeniolatus* (Jerdon, 1853) is a junior synonym of *Oligodon taeniolatus* (Daudin, 1803). This conclusion stems from the fact that Daudin's name appears based entirely on the specimen described and figured by Russell (1796) as the "wanapa pam" and that the description of Jerdon (1853) is likewise based, at least in part, on the same specimen (indeed no other types appear to be extant fide Das et al., 1998, but see comments above). Ordinarily, the principle of priority would dictate that the correct scientific name of the streaked kukri snake should be *Oligodon taeniolatus* (Daudin, 1803). However, Article 23.9 of The International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature, 1999) provides for the reversal of temporal precedence when 1) "the senior synonym or homonym has not been used as a valid name after 1899" (Art. 23.9.1.1) and 2) "the junior synonym or homonym has been used for a particular taxon, as its presumed valid name, in at least 25 works, published by at least 10 authors in the immediately preceding 50 years and encompassing a span of not less than 10 years" (Art. 23.9.1.2). The first provision is unquestionably satisfied. It is clear that *Coluber taeniolatus* Daudin, 1803 has not been employed as a valid name since the early 19th century. Indeed I can find no references postdating the description itself that unambiguously use the name as valid and clearly attribute authorship to Daudin; Merrem (1820) and Cantor (1847) cited the name in synonymy only, Gray (1831) attributed the name to Boie, Jerdon (1870) may or may not have been attributing the name to Daudin (see above), and Sherborn (1931) used the name only in a nomenclator. The second provision is complicated by the fact that the older name is both a synonym and a secondary homonym of the younger. Thus, only citations that explicitly cite Jerdon as the author of *O. taeniolatus* provide unambiguous reference to the younger name (in contrast to non-homonymous synonyms, which are readily distinguished). Nonetheless, I was able to identify 26 publications by 16 different authors or combinations of authors, spanning the period 1965-2000, all of which cite the name as *Oligodon taeniolatus* (or *O. taeniolatum*; the former [masculine] formation is correct as the stem of the generic name, *-odon*, is derived from the Greek masculine noun "odous," meaning tooth) (Sharma, 1965, 1982a, 1982b; Minton, 1966; Mertens, 1969; Murthy, 1978, 1982, 1985, 1986, 1990; De Silva, 1980; Khan, 1982, 1993; Daniel, 1983; Mahendra, 1984; Welch, 1988; Ghatpande et al., 1990; Sanyal et al., 1993; Das, 1994, 1996, 1997, 1998; Thomas et al., 1997; Das et al., 1998; Gayen, 1999; Kalaiarasan, 2000). A single citation attributing the name to Wall (Thomas and Easa, 1997) appears to reflect a simple error rather than an alternative interpretation of nomenclatural history. As both provisions are thus fulfilled, under Article 23.9.2, from the date of this publication, as long as the two names are considered synonyms, *Oligodon taeniolatus* (Jerdon, 1853) becomes a nomen protectum with precedence over the older *O. taeniolatus* (Daudin, 1803) which is to be considered a nomen oblitum.

As noted above, Jerdon's *Coronella taeniolatus* is based on two specimens – the "wanapa pam" illustrated by Russell (1796: pl. 19), and an unlocated specimen for which he provides ventral scale counts. The former specimen

(also unlocated) is also the holotype of *Coluber taeniolatus* Daudin, 1803. The names of Daudin and Jerdon are thus, at least in part, objective synonyms as well as secondary homonyms. I here select their shared type specimen, illustrated by Russell, with the type locality "Vizagapatam" as the lectotype of *Coronella taeniolatus* Jerdon, 1853. Thus both names share a common primary type and are strict objective synonyms of one another. This action ensures stability of the situation by effectively rendering permanent the status of the older name as a nomen oblitum and that of the younger name as a nomen protectum.

DISCUSSION

The invocation of Article 23.9 of The International Code of Zoological Nomenclature in this instance may be viewed as controversial by some. As noted above, an alternative interpretation of the problem of the authorship of the streaked kukri snake is that Jerdon (1853) intended to refer to Daudin's (1803) *Coluber taeniolatus* and that the real issue is not one of the synonymy and homonymy of Daudin's and Jerdon's names, but merely one of incorrect attribution of authorship. Under such an interpretation Jerdon's (1853) use of *Coronella taeniolata* constitutes only a new combination and all subsequent confusion is the result of Wall's (1909) misinterpretation of this as a species description (and the near universal adoption of this view by other authors). Although I agree that such an argument has merit, I have made the case that Jerdon (1853) did intend to propose a new name. Jerdon may have been aware of Daudin's work, or at least Cantor's (1847) reference to Daudin's name in synonymy, but there is no direct evidence of this in the description itself. That Jerdon (1853) cited other names authored by Daudin is not clear evidence of his intentions in this instance. Indeed, that Daudin's *Coluber taeniolatus* was overlooked by Duméril et al. (1854), Günther (1864), and Boulenger (1890, 1894) amongst others is ample evidence that such oversight was not uncommon, even among relatively careful workers. Admitedly Jerdon's (1870) later comments are more suggestive that he was aware of Daudin's description, but what he was aware of in 1870 is not really relevant to his 1853 account of *C. taeniolata*. Accepting that Jerdon's use of the name constitutes a description, the invocation of Article 23.9 is clearly justified. If this interpretation is proven erroneous and subsequent workers demonstrate that Jerdon (1853) did not provide a valid description for the streaked kukri snake, then the designation of *Oligodon taeniolatus* (Jerdon, 1853) as a nomen protectum may legitimately be challenged, and under Article 23.11 an application to replace this name may be made to the Commission for a ruling under the plenary power. Regardless, the objective synonymy and secondary homonymy of the two names ensures that the stability of the name *Oligodon taeniolatus*, if not its authorship.

In retrospect, it appears that the disappearance of the name *Coluber taeniolatus* Daudin, 1803 was initiated by its inclusion in synonymy by Merrem (1820). Although many of Merrem's synonymies were subsequently critically analyzed and found to contain errors (Boie, 1827), the name had already become obscure. Interestingly, another error by Merrem (1820), the use of the unjustifiably emended name *Rana tigrina* for *R. tigerina* Daudin, 1802, a common South Asian frog, likewise, resulted in nearly two centuries of the application of an incorrect name by subsequent workers (Dutta, 1985).

ACKNOWLEDGEMENTS

I thank Van Wallach, and especially Patrick David for their useful comments on the manuscript.

LITERATURE CITED

BEDDOME, R. H. 1862. Notes upon the land and fresh-water snakes of the Madras Presidency. *Madras Quart. J. Med. Sci*. 5: 1-31, pl. 2.

________. 1863. Further notes upon the snakes of the Madras Presidency; with descriptions of new species. *Madras Quart. J. Med. Sci.* 6: 41-48, 5 pls.

BLANFORD, W. T. 1879. Notes on a collection of reptiles and frogs from the neighbourhood of Ellore and Dumagudem. *J. Asiatic Soc. Bengal* 48: 110-116.

BOIE, F. 1827. Bemerkungen über Merrem's Versuch eines Systems der Amphibien. Mar-

burg. 1820. 1te Lieferung: Ophidier. *Isis von Oken* 20: columns 508-566.

BOULENGER, G. A. 1890. The fauna of British India, including Ceylon and Burma. Reptilias and Batrachia. Secretary of State for India in Council, London. xviii, 541 pp.

________. 1894. Catalogue of the snakes in the British Museum (Natural History). Volume II, containing the conclusion of the Colubridae Aglyphae. Trustees of the British Museum (Natural History), London. xi, 382 pp., 20 pls.

CANTOR, T. 1847. Catalogue of reptiles inhabiting the Malayan Peninsula and islands. Asiatic Society of Bengal, Calcutta. 157 pp., 2 pls. [extracted from *J. Asiatic Soc. Bengal* 16].

CAZALY, W. H. 1914. The common snakes of India and Burma and how to recognise them. The Pioneer Press, Allahabad. ii, [i], 60, [i], 11 pp. figs., [i]-iv.

CONSTABLE, J. D. 1949. Reptiles from the Indian Peninsula in the Museum of Comparative Zoology. *Bull. Mus. Comp. Zool.* 103: 57-160.

DANIEL, J. C. 1983. The book of Indian Reptiles. Bombay Natural History Society, Bombay. x, 141 pp., 54 pp. pls.

DAS, I. 1994. The reptiles of South Asia: checklist and distributional summary. *Hamadryad* 19: 15-40.

________. 1996. Biogeography of the reptiles of South Asia. Krieger Publishing Company, Malabar, Florida. 16 pp. pls., vii, 87 pp.

________. 1997. Checklist of the reptiles of India with English common names. *Hamadryad* 22: 32-45.

________. 1998. The serpent's tongue. A contribution to the ethnoherpetology of India and adjacent countries. Edition Chimaira, Frankfurt am Main. 121 pp.

________, B. DATTAGUPTA & N. C. GAYEN. 1998. History and catalogue of reptile types in the collection of the Zoological Survey of India. *J. South Asian nat. Hist.* 3: 121-172.

DAUDIN, F.-M. An XI. 1803. Histoire Naturelle, Générale et Particulière des Reptiles. Ouvrage Faisant Suite aux Oeuvres de Leclerc de Buffon, et Partie du Cours Complet d'Histoire Naturelle Rédigé par C. S. Sonnini, Member de Plusieurs Sociétés Savantes. Tome sixième. Imprimerie F. Dufart, Paris. 447 pp., pls. lxxi-lxxx.

DAVID, P. & I. INEICH. 1999. Les serpents venimeux du monde: systématique et répartition. *Dumerilia* 3: 3-499.

DE SILVA, P. H. D. H. 1980. Snakes of Sri Lanka, with special reference to skull, dentition and venom in snakes. National Museums of Sri Lanka, Colombo. Frontispiece, xi, 472 pp., correction slip.

DUMÉRIL, A.-M.-C., G. BIBRON & A.-H.-A. DUMÉRIL. 1854. Erpétologie Générale ou Histoire Naturelle Complète des Reptiles. Tome septième. Première Partie, Comprenant l'Histoire des Serpents Non Venimeux. Librairie Encyclopédique de Roret, Paris. vii, [4], xvi, 780 pp, 1 folding table, pls. 59, 63, 70, 72, 75-82.

DUTTA, S. K. 1985. Notes on the correct spelling of the Indian bull frog, Rana tigerina Daudin. *J. Bombay nat. Hist. Soc.* 82: 220-221.

FERGUSON, W. 1977. Reptile fauna of Ceylon. Ceylon Government, Colombo. 42 pp.

FITZINGER, L. 1826. Neue Classification der Reptilien nach ihren natürlichen Verwandtschaften, nebst einer Verwandtschafts-Tafel und einem Verzeichnisse der Reptilien-Sammlung des K.K. Zoologischen Museum's zu Wien. J. G. Heubner, Wien. [1], [1],[4], 66 pp., 1 folding table.

FRASER, A. G. L. 1937. The snakes of Deolali. With notes on their comparative osteology and peculiarities of dentition. *J. Bombay nat. Hist. Soc.* 39: 464-501, pls. VI-IX.

GAYEN, N. C. 1999. A synopsis of the reptiles of Gujarat, western India. *Hamadryad* 24: 1-22.

GHATPANDE, S. K., S. JOSHI & A. KHAIRE. 1990. Additional information on the ophiological fauna of Pune region. *Herpeton* 3: 1-2.

GOLAY, P., H. M. SMITH, D. G. BROADLEY, J. R. DIXON, C. McCARTHY, J. C. RAGE, B. SCHÄTTI & M. TORIBA. 1993. Endoglyphs and other major venomous snakes of the world. A checklist. Azemiops S.A., Herpetological Data Center, Aïre-Genève. xv, 478 pp.

GRAY, J. E. 1831. A synopsis of the species of the Class Reptilia. Appendix *In*: The animal kingdom arranged in conformity with its organization, by the Baron Cuvier, vol. 9. pp. 1-110. E. Griffith & E. Pidgeon (Eds). Whittaker, Treacher and Co., London.

GÜNTHER, A. C. L. G. 1858. Catalogue of the colubrine snakes in the collection of the British Museum. Trustees of the British Museum, London. xvi, 281 pp.

________. 1864. The reptiles of British India. The Ray Society, London. xxvii, 452, 26 pls.,

HOGE, A. R. & ROMANO HOGE, S. A. R. W. L. 1981. Poisonous snakes of the world. Part I. Check-list of the pit vipers Viperoidea, Crotalinae. *Mem. Inst. Butantan* 42/43 [1978/1979]:179-310.

International Commission on Zoological Nomenclature. 1999. International Code of Zoological Nomenclature, Fourth Edition. International Trust for Zoological Nomenclature, London. xxix + 306 pp.

JERDON, T. C. 1853. Catalogue of reptiles inhabiting the Peninsula of India. *J. Asiatic Soc. Bengal* 22: 462-479, 522-534.

________. 1870. Notes on Indian herpetology. *Proc. J. Asiatic Soc. Bengal* 1870: 66-85.

KALAIARASAN, V. 2000. An account of reptiles in the Guindy National Park. *Cobra* 39: 3-12.

KHAN, M.S. 1982. An annotated checklist and key to the reptiles of Pakistan. Part III: Serpentes. *Biologia (Lahore)* 28: 215-254.

________. 1993. Snakes of Pakistan [in Urdu]. Lahore Science Board, Lahore, Pakistan. 208 pp., 12 pp. pls.

MAHENDRA, B. C. 1984. Handbook of the snakes of India, Ceylon, Burma, Bangladesh, and Pakistan. *Ann. Zool*. 22: i-xvi, 1-412.

McDIARMID, R. W., J. A. CAMPBELL & T. A. TOURÉ. 1999. Snake species of the world, a taxonomic and geographic reference. Vol. 1. The Herpetologists' League, Washington, D.C. 511 pp.

MERREM, B. 1820. Versuch eines Systems der Amphibien/Tentamen systematis amphibiorum. Johann Chrisitan Krieger, Marburg. xv + 188 pp/xv + 191 pp., 1 pl. [parallel German and Latin texts, each with its own pagination].

MERTENS, R. 1969. Die Amphibien und Reptilien West-Pakistans. *Stuttgart. Beitr. z. Naturk.* (197): 1-96.

MINTON, S. A., JR. 1966. A contribution to the herpetology of West Pakistan. *Bull. American Mus. nat. Hist*. 134: 27-184, pls. 9-36.

MURRAY, J. A. 1884. The vertebrate zoology of Sind; a systematic account with descriptions of all the known species of mammals, birds, and reptiles inhabiting the Province; observations on their habits, &c.; tables of their geographical distribution in Persia, Beloochistan, and Afghanistan; Punjab, North-West Provinces, and the Peninsula of India Generally. Richardson & Co., London. vi, 92, [3] pp., 7 pls.

________. 1886. The reptiles of Sind; a systematic account with descriptions of all the species Inhabiting the Province, and a table of their geographical distribution in Persia, Beloochistan, Afghanistan, Punjab, North-West Provinces, and the Peninsula of India generally. Richardson & Co., London. xvi, 424, 13 pls.

MURTHY, T. S. N. 1978. The herpetofauna of Madras and its vicinity. *Hamadryad* 3(2): 7-12.

________. 1982. A contribution to the ophiology of Western Ghats, India. *The Snake* 14: 50-56.

________. 1985. Classification and distribution of the reptiles of India. *The Snake* 17: 48-71.

________. 1986. The snake book of India. International Book Distributors, Dehra Dun. [xxiv], 22 pp. pls., 101 pp., 1 p. errata.

________. 1990. Illustrated guide to the snakes of the Western Ghats, India. *Rec. Zool. Surv. India Occ. Pap.* (114): i, 1-76 pp., 38 pp. pls.

NICHOLSON, E. 1874. Indian snakes. An Elementary Treatise on ophiology with a descriptive catalogue of the snakes found in India and the adjoining countries, 2nd ed. Higginbotham and Co., Madras. [ix], 188 pp., 20 pls.

RUSSELL, P. 1796. An account of Indian serpents collected on the coast of Coromandel; containing descriptions and drawings of each

species; together with experiments and remarks on their several poisons. George Nicol, London. viii + 91 pp., 46 pls. (on 45 leaves).

________.1801-1810. A continuation of an account of Indian Serpents; containing descriptions and figures, from specimens and drawings transmitted from various points of India, to the Hon. the Court of Directors of the East India Company [part 1]. G. and W. Nicol, London. v, ix-xv, 53, (4) pp.; 45 pls. (on 41 leaves).

SANYAL, D. P., B. DATTAGUPTA & N. C. GAYEN. 1993. Reptilia. *In*: State Fauna Series 5. Fauna of Andhra Pradesh. Part 1 (Reptilia, Amphibia, Fishes). pp: 1-63. A. K. Ghosh (Ed). Zoological Survey of India, Calcutta.

SCHLEGEL, H. 1826. Notice sur l'erpétologie de l'ile de Java. *Bull. Sci. Nat. Géol.* 9: 233-240.

________. 1837. Essai sur la Physionomie des Serpens. Partie Descriptive. M. H. Schonekat, Amsterdam. 606 + xv pp; errata.

SCLATER, W. L. 1891a. Notes on the collection of snakes in the Indian Museum with descriptions of several new species. *J. Asiatic Soc. Bengal* 60: 230-250; pl. VI.

________. 1891b. List of the snakes in the Indian Museum. Trustees of the Indian Museum, Calcutta. x + 79 pp.

SHARMA, R. C. 1965. The reptile fauna of the Nagarjunasagar Dam area (Andhra Pradesh, India). *Rec. Zool. Surv. India* 63: 77-93.

________. 1982a. Taxonomic and ecological studies on the reptiles of Gujarat. *Rec. Zool. Surv. India* 80: 85-106.

________. 1982b. Studies on pholidosis and variability in characters showing sexual dimorphism in various species of Indian reptiles. *Rec. Zool. Surv. India Misc. Publ. Occ. Pap.* (35): 1-153.

SHERBORN, C. D. 1931. Index Animalium sive Index Nominum quae ab A.D. MDCCLVIII Generibus et Speciebus Animalium Imposita Sunt. Sectio Secunda a Kalenis Ianuarrs, MDCCCI usque ad Finem Decembris, MDCCCL. Part XXVI. Index T-*Trichoscelia*. pp: 6359-6582. Trustees of the British Museum, London.

SMITH, H. M. & P. DAVID. 1999. George Shaw and the herpetology volume in his series, General Zoology. *In*: General Zoology. Volume III. Amphibians and Reptiles. pp: 5-96. G. Shaw. New York, Society for the Study of Amphibians and Reptiles, Ithaca.

SMITH, M. A. 1943. The fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese Sub-region. Reptilia and Amphibia. Vol. III. Serpentes. Taylor and Francis, London. xii, 583 pp.

THEOBALD, W. 1868. Catalogue of reptiles in the Museum of the Asiatic Society of Bengal. *J. Asiatic Soc. Bengal*. 37, extra number (146): (2), [i]-vi, 7-88, [i]-iii, (1), pls. 1-4.

THOMAS, J. & P. S. EASA. 1997. Reptile fauna of Peechi-Vazhani Wildlife Sanctuary. *Cobra* 29: 14-18.

________, S. JAHAS & P. S. EASA. 1997. Status and distribution of reptiles in Wayanad, Kerala. *Cobra* 28: 25-30.

ULBER, T. 1996. Editorial note. *In*: Synopsis of the Species of the Class Reptilia (Facsimile edition). pp: i-xx. J. E. Gray. Herprint International CC, Bredell, South Africa.

WAGLER, J. G. 1830. Natürliches System der Amphibien, mit vorangehender Classification der Säugthiere und Vögel. G. J. Cotta'schen Buchhandlung, München. vi + 354 pp, 2 folding pls.

WALL, F. 1905. Notes on snakes collected in Cannanore from 5th November 1903 to 5th August made in the Nilgiri Hills and the adjacent Wynaad. *J. Bombay nat. Hist. Soc.* 16: 292-317.

________. 1909. A popular treatise on the common Indian snakes. Part XI. *J. Bombay nat. Hist. Soc.* 19: 555-563, diagram 1, pl. XI.

________. 1919. Notes on a collection of snakes made in the Nilgiri Hills and the adjacent Wynaad. *J. Bombay nat. Hist. Soc*. 26: 552-584, map 1, pls. I-III.

________. 1921. Ophidia Taprobanica or the snakes of Ceylon. Colombo Museum, Colombo. xxii, [i], 581 pp., map.

________. 1923a. A hand-list of the snakes of the Indian Empire. Part II. *J. Bombay nat. Hist. Soc.* 29: 598-632.

________. 1923b. A review of the Indian species of the genus *Oligodon* suppressing the genus *Simotes* (Ophidia). *Rec. Indian Mus*. 25: 305-334.

WELCH, K. R. G. 1988. Snakes of the Orient: a checklist. Robert E. Krieger Publishing Company, Malabar, Florida. vii + 183 pp.

Received: 9 September 2002.
Accepted: 5 November 2002.

Hamadryad Vol. 27, No. 2, pp. 214 – 216, 2003.

CHITRA BURMANICA SENSU JARUTHANIN, 2002 (TESTUDINES: TRIONYCHIDAE): AN UNAVAILABLE NAME

William P. McCord[1], Olivier S. G. Pauwels[2], Roger Bour[3],
Frédéric Chérot[4], John Iverson[5], Peter C. H. Pritchard[6],
Kumthorn Thirakhupt[7], Wachira Kitimasak[8] and Thanakhom Bundhitwongrut[9]

[1]East Fishkill Animal Hosp., 455 Rt. 82, Hopewell Jct., N.Y., 12533, U.S.A.
Email: chelodina@aol.com
[2]Department of Recent Vertebrates, Institut Royal des Sciences naturelles de Belgique,
Rue Vautier 29, 1000 Brussels, Belgium.
[3]Labaratoire des Reptiles et Amphibiens, Muséum national d'Histoire naturelle,
25 Rue Cuvier, 75005, Paris, France
[4]Labaratoire de Systématique et d'Ecologie animales, Université Libre de Bruxelles,
c. p. 160/13, Av. F. D. Roosevelt 50, 1050 Brussels, Belgium.
[5]Department of Biology, Earlham College, Richmond, Indiana, 47374, U.S.A.
[6]Chelonian Research Institute, 402 S. Central Ave., Oviedo, FL., 32765, U.S.A.
[7]Department of Biology, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand.
[8]Kanchanaburi Inland Fisheries Research and Development Center, Tha Moung, Kanchanaburi 71110, Thailand.
[9]Crustacean Section, Natural History Museum, National Science Museum, Technopolis,
Klong 5, Klong Luang, Pathumthani 12120, Thailand.

ABSTRACT.– The name *Chitra burmanica*, as given to Myanmar *Chitra* by Kittipong Jaruthanin (2002: 32), is evaluated in light of the application of the fourth edition (1999) of the International Code of Zoological Nomenclature (ICZN). According to our analysis, the name *Chitra burmanica* is a *nomen nudum,* and thus unavailable.

KEYWORDS.– *Chitra burmanica, Chitra vandijki*, International Code of Zoological Nomenclature, *nomen nudum*.

INTRODUCTION

On 7 November, 2001, K. Jaruthanin and part of a group of over forty ichthyology colleagues visited a local market in Mae Sot, Tak Province, north-western Thailand, where he met with friends known to import fresh seafood and fish from Myanmar. Here, he observed several species of turtles, including softshell specimens referable to the genus *Chitra* Gray, 1844 (Jaruthanin, 2002: 32). A colour photo with the caption "Myanmar *Chitra*" (manlaï Phama) accompanies the article translated below as photo number 7 on p. 40, but no reference is made to this photo in the text. The Thai to English translation of the pertinent section of Jaruthanin (2002) is as follows [note we have bracketed our comments, and italicized the Thai vernacular names]:

"…. Besides the fresh prawns, crabs and fish, there were live hardshell and softshell turtles which were all very interesting. We encountered *tao dao Phama* (BURMESE STAR TOR TOISE [*sic*]; Geoehelone [*sic*] platynota); *tao nok young* (PEACOCK TURTLE; Morenia ocelata [*sic*]); *tao pulu* (BIGHEAD TURTLE; Platysternon megacephalum vogeli) and also two species of *taphab nam* [softshell turtles]: *taphab hab phama* (BOX SOFT SHELL TURTLE; Lysemys [*sic*] scutata) and *taphab manlaï Phama* (BURMESE GIANT SOFT SHELL TURTLE; Chitra sp.). The *taphab manlaï* [= *Chitra* sp.] came from Myanmar; it is a *taphab* [= soft shell turtle] which has unique characters. It was not possible to directly identify this species with certainty because it seems to be between *manlaï* India (Chitra indica) and the *manlaï* species of Thailand and Malaysia (Chitra chitra). These intermediate characters can qualify *manlaï Phama* [Myanmar *Chitra*] as a new distinct species, for which the most convenient scientific name should be Chitra burmanica. But then

again, this might invalidate the differences separating the species *manlaï* India and *manlaï* Thai [i.e., *C. indica* & *C. chitra*] and would thus make them all only one and the same animal species known formerly as Chitra indica …..".

COMMENTS AND DISCUSSION

Our interest is to evaluate objectively the availability of the name *Chitra burmanica* as used by Jaruthanin (2002: 32), in light of the specific rules set down in the fourth edition of the Code (ICZN, 1999). Five critical sections of the Code are pertinent to our discussions:

(1) Article 13.1 clearly states as a "requirement" that to be available a name published after 1930 must either "be accompanied by a description or definition that states in words characters that are purported to differentiate the taxon" (Article 13.1.1), or "be accompanied by a bibliographic reference to such a published statement" (Article 13.1.2). Jaruthanin (2002: 32) does not provide a description in words to distinguish *Chitra burmanica* from other taxa, nor did he include a specific bibliographic reference giving such a published description. We consider the term "intermediate" to be unacceptable as a "description or definition", because it gives no objective information about characters to identify *C. burmanica*.

(2) Article 13.6.1 under "Exclusions" (from availability) states that "A name proposed after 1930 cannot be made available by the methods of "indication" listed in Article …. 12.2.7." Therefore, the illustration of *Chitra burmanica*, published in 2002, cannot be considered as an "indication" in the sense of Article 12.2.7, and thus does not make Jaruthanin's name available.

(3) Article 15.1 concerning "Conditional proposal" states that "A new name or nomenclatural act proposed conditionally and published after 1960 is not thereby made available". In the case of Jaruthanin (2002: 32), the proposal of the name *Chitra burmanica* for Myanmar *Chitra* is essentially conditional. The author states that the Myanmar form appears "intermediate" with regard to *Chitra indica* (Gray, 1831) and *Chitra chitra* "(=Nutphand)", 1986, and that all three forms may represent one species (thereby conditionally stating that the valid name of the Myanmar taxon could be *C. indica*). Thus, in Jaruthanin (2002) the species name *Chitra burmanica* would only be available on the condition that Myanmar *Chitra* are not really *C. indica*, which the author did not establish.

(4) Article 16.4 states "Every new specific …. name published after 1999, …. must be accompanied in the original publication by the explicit [not implied] fixation of a holotype, or syntypes, for the nominal taxon" (Article 16.4.1). This requirement is also specified in Article 72.3: "A proposal of a new nominal species-group taxon after 1999 …. must include the fixation of a holotype …. or syntypes ….". Jaruthanin did not explicitly fix a holotype by original designation (according to Article 73.1.1). He further complicates the question of availability of his new name by mentioning an undefined plural number of specimens examined in the market, with no stated location for any of them, or even whether they were ever purchased, preserved and archived. It is not possible to know how many or what specimens he saw. Thus we cannot assume a holotype by monotypy (according to Article 73.1.2).

(5) Article 73.2.1.1 under "Syntypes" states "When a nominal taxon is established after 1999, only those specimens expressly indicated by the author as those upon which the new taxon is based …. are syntypes.". Jaruthanin (2002) does not expressly indicate syntypes.

The clear result of interpreting the ICZN (1999), as given above, is to declare the name *Chitra burmanica* Jaruthanin, 2002 a *nomen nudum*, and thus unavailable. We consider *Chitra vandijki* McCord & Pritchard, 2003 to be the valid name for Myanmar *Chitra*.

ACKNOWLEDGEMENTS

We thank both Mrs. Chucheep Chimsunchart (Phetchaburi) and Karn Lekagul (Bangkok) for

translation from Thai to English, and Jonathan Murray (Bangkok) for bringing this matter to the attention of the authors.

LITERATURE CITED

GRAY, J. E. 1831. A synopsis of the species of the Class Reptilia. *In*: The Class Reptilia, arranged by the Baron Cuvier, with specific descriptions. E. Griffith & E. Pigeon (Eds). Vol. 9. pp: 1-110. Whittaker, Treacher & Co., London.

________. 1844. Catalogue of the tortoises, crocodiles and amphisbaenians, in the collection of the British Museum. British Museum, London. 80 pp.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE. 1999. International Code of Zoological Nomenclature. Fourth edition. International Trust for Zoological Nomenclature, London. 306 pp.

JARUTHANIN, K. 2002. [Go along Salaween. Visit a place with rare fish] Salaween: the dangerous river. Talui thin pla hayak. *Fish Zone*, Bangkok 3 (19): 27-40. [In Thai.]

McCORD, W. P. & P. C. H. PRITCHARD. 2003 ("2002"). A review of the softshell turtles of the genus *Chitra*, with the description of new taxa from Myanmar and Indonesia (Java). *Hamadryad* 27 (1): 11-56.

NUTAPHAND, W. 1986. [Manlai. The world's biggest softshell turtle]. *Thai Zool. Mag.* 1 (4): 64-70. [In Thai.]

Received: 28 April 2003.
Accepted: 17 May 2003.

Hamadryad Vol. 27, No. 2, pp. 217 – 221, 2003.

NOTES ON THE DISTRIBUTION, NATURAL HISTORY AND VARIATION OF *HEMIDACTYLUS GIGANTEUS* STOLICZKA, 1871

Varad Giri[1], Aaron M. Bauer[2] and Naresh Chaturvedi[1]

[1]Bombay Natural History Society, Hornbill House, Dr. Salim Ali Chowk, S. B. S. Road, Mumbai 400 023, India. Email: bnhs@bom4.vsnl.net.in
[2]Department of Biology, Villanova University, 800 Lancaster Avenue, Villanova, Pennsylvania 19085 USA. Email: aaron.bauer@villanova.edu

(with two text-figures)

ABSTRACT.– A recently collected specimen of *Hemidactylus giganteus* from Basapur, Karnataka provides some new insights into the diet and habitat of this uncommon species of gecko. This specimen and others in the collection of the Bombay Natural History Society (BNHS) were examined to assess morphological variation with respect to published information about the species. Although traditionally regarded as an arboreal species, *H. giganteus* appears to be rupicolous, at least at Basapur.

KEYWORDS.– *Hemidactylus giganteus*, BNHS collection, lamellae, femoral pores, variation, distribution.

INTRODUCTION

Hemidactylus giganteus is one of the largest Indian geckos, reaching a snout-vent length of at least 115 mm (Smith, 1935). Stoliczka (1871, 1872) described the species on the basis of a series of specimens collected "on the Godávári river near Badráchalam [Bhadrachalam, Andhra Pradesh], on trees". Smith (1935), more than 60 years later, noted that the species was still known from only a few specimens and recorded the species range as "Godavary Valley [Andhra Pradesh]; Malabar [Kerala]; Lingsugur, Hyderabad State [Karnataka]; Palkonda Hills (Guvvalacheruvu) [Andhra Pradesh]". The first records from Maharashtra were reported from Pandava Caves, Kolaba District (Soman, 1966) and Ozar, Nasik District (Chopra, 1968). Murthy (1985, 1990) added localities in the Kurnool District, Andhra Pradesh and the Malappuram and Wayanad Districts, Kerala. Sanyal and Dasgupta (1990) reported several localities for *H. giganteus* in the Bastar District of what is now Chhattisgarh and Tikader and Sharma (1992) and Sanyal et al. (1993) noted additional localities in Andhra Pradesh in the Adilabad, Guntur, Karimnagar, Mahbubnagar, Warangal, and Nellore districts, as well as from the Thane District in Maharashtra, and from Madras [Chennai], Tamil Nadu. Daniels (2001) also cited the species in a list of reptiles of the Eastern and Western Ghats of Tamil Nadu, but the basis for this citation is unclear, as published records for the Eastern Ghats come from Andhra Pradesh (Tikader and Sharma, 1992; Sanyal et al., 1993), whereas those from the Western Ghats are from Kerala (Murthy, 1985).

Finally, Waltair, Andhra Pradesh and Aurangabad, Maharashtra have been reported as localities in the parasitological literature (Madre, 1978, 1979; Saratchandra, 1981), but these references have previously escaped the notice of most herpetologists.

The accumulated distribution records confirm that *Hemidactylus giganteus* is widespread throughout most of peninsular India, yet it remains one of the most poorly known geckos in the region, and despite its wide range, it has been considered rare by many recent reviewers (e.g., Murthy 1990; Tikader and Sharma 1992). Recently a specimen of *Hemidactylus giganteus* (BNHS 1015) was collected from Basapur, Karnataka and deposited in the collection of Bombay Natural History Society (BNHS). The BNHS collection also houses five older speci-

mens of this species. While one of these (BNHS 206) is without specific locality data, the remaining four (BNHS 1259/1-4) were collected from Sirauncha, West Chanda, Maharashtra. As there is almost no published information about the natural history or morphological variation in this species, we take this opportunity to provide some data derived both from the newly acquired specimen and the older museum material in Mumbai.

MATERIALS AND METHODS

The recently deposited specimen of *Hemidactylus giganteus* from Karnataka (BNHS 1015) was collected by hand and stomach flushed within eight hours to obtain dietary information. The specimen was euthanised, fixed in 10% formalin, and transferred into 70% ethanol. Measurements were taken with a Mitutoyo dial caliper (to the nearest 0.05 mm). The following measurements were recorded for each specimen. Snout-vent length (SVL); tail length (TL); axila-groin length (AG); head length from posterior edge of mandible to snout tip (HL); maximal head width (HW); maximal head depth (HD); eye diameter (ED); distance from posterior border of orbit to anterior margin of ear (EE); the distance from anterior border of orbit to tip of snout (ES). Characteristics of femoral pores (FP), number of supralabials (SL) and infralabials (IL) and number of lamellae under first toe (L 1st) and fourth toe (L 4th) were also recorded.

RESULTS

Locality and habitat.- The specimen of *Hemidactylus giganteus* was collected from near Basapur village, Koppal District, Karnataka (15° 20' 24.5"N; 76° 25' 20.3"E; altitude 467 m) on 10 November 2002 at about 2130 h. Although the species has recently been listed in a checklist of the Karnataka herpetofauna (Daniels, 2000), this is apparently based on the Lingsugur record of Smith (1935). Thus the Basapur specimen represents only the second confirmed locality for *H. giganteus* in the state. Likewise, the specimens from Sirauncha, Maharashtra constitute only the fifth published record for that state.

The landscape near Basapur is dominated by granite boulders with river sand, gravel and loose soil in patches. At the time of collection it had recently rained and winged termites and other insects were active. About 20 *Hemidactylus giganteus* were observed near Basapur on the night of 10 November 2002. The preferred substrate of the species there appeared to be granite boulders which match the colouration of the geckos to a remarkable degree. Most individuals were observed actively moving and foraging on boulders close to human habitation and many were seen in or close to cracks on the ground. This habitat is also shared by *Hemidactylus* c.f. *brookii*, *Psammophilus* sp. and *Cnemaspis* sp. No *H. giganteus* were seen on trees.

These observations are at odds with Stoliczka's (1872) original statement about the microhabitat of *Hemidactylus giganteus* and with the later assessments of Smith (1935) and Murthy (1990) who regarded it as a strictly arboreal species. Indeed, both Murthy (1990) and Tikader and Sharma (1992) used the English vernacular name "Giant Tree Gecko" to refer to this species. The latter authors reported this to be a strongly arboreal species and noted that all the specimens from Andhra Pradesh were collected from trees in hilly country. Murthy (1985), however, observed geckos of this species in crevices in the ceiling of a fortress at Gooty and in the arches of a temple at Ahobilam, both in Andhra Pradesh, and Sanyal et al. (1993) noted simply "found on trees, crevices". It is likely that the species can occupy either arboreal or rupicolous micohabitats, but its large size and requirement for suitably commodious retreat sites may favor the occupation of natural or manmade stone crevices in most areas. It is also possible that the species is chiefly associated with rocks, but may move onto trees to forage at night, as has been reported for some other large geckos (Bauer 1990).

Morphological characters.- In *Hemidactylus giganteus*, the digits are free, moderately dilated and with almost straight transverse lamellae. Previous authors have reported 10-11 lamellae beneath the first toe and 13-15 under the fourth toe (e.g., Smith, 1935; Tikader and Sharma, 1992).

TABLE 1: Mensual and meristic data for *Hemidactylus giganteus* from Karnataka and Maharashtra in the collection of the Bombay Natural History Society. Abbreviations as in Materials and Methods. All mensural data in mm. Abbreviations: * = Tail regenerated; TB = Tail broken.

		Mensural Characters										Meristic Characters			
BNHS No.	Sex	SVL	TL	AG	HL	HW	HD	ED	EE	ES	FP	SL	IL	L 1st	L 4th
1510	Male	108.80	110.00	44.50	32.10	23.40	13.10	6.80	8.00	14.00	18 (left) 17 (right)	14	10	11	14
1259/1	Female	102.40	80.00*	42.50	31.20	22.80	12.50	6.80	9.70	13.90	-	14	12	11	14
1259/2	Female	107.20	62.40*	43.00	33.00	22.60	13.10	6.90	9.80	14.30	-	13	12	10	15
1259/3	Male	92.50	96.00	40.00	26.80	21.30	11.50	5.50	9.40	11.70	16 (left) 18(right)	14	12	11	14
1259/4	Female	84.80	90.10	36.30	21.00	19.00	12.10	5.40	7.30	11.68	-	13	13	10	15
206	Male	101.10	TB	41.40	31.20	22.50	13.00	6.70	9.50	12.10	17 (left) 17 (right)	14	12	11	14

Our observations of material from Karnataka and Maharashtra confirm these ranges (Table 1). Previous authors, however, have not commented on the fact that the lamellae are divided distally, but single basally (Fig. 1). Variation in the degree of lamellar division is high across *Hemidactylus* as a whole, and there is a tendency towards undivided lamellae in Indian members of the genus, culminating in *H. anamallensis* (fide Bauer and Russell, 1995).

Smith (1935) and Tikader and Sharma (1992) described males of *Hemidactylus giganteus* as having 18-22 femoral pores per thigh, with the left and right series separated by a small median gap. While this was generally borne out by the BNHS material, as few as 16 pores were found in BNHS 1259/3 (Table 1), and in BNHS 1510 the pores of the left femur were not continuous, but were interrupted by poreless scales (Fig. 2), while in two other specimens (BNHS 1259/3 and BNHS 206) the left and right femoral pore series are continuous across the precloacal region, with no median gap.

Diet.- Dietary composition was determined by stomach flushing a single specimen (BNHS 1510) within eight hours of collection. It contained 12 specimens of winged termites. It is probable that the diet of *Hemidactylus giganteus* is actually fairly catholic, but that the stomach contents retrieved from this individual represent the capitalization on an eruption of a temporally and spatially patchy resource, alate termites. Such prey utilization has been noted in many lizards, including geckos in Punjab (Arora, 1962) and elsewhere in Asia (Frith, 1981). The only specific mention of diet in this species has been with respect to captive specimens, which were fed cockroaches (*Blaberus* spp.; Klátil, 1988).

CONCLUSIONS

Hemidactylus giganteus has generally been considered a rare species (e.g., Murthy, 1990; Tikader and Sharma, 1992), or at least a species of indeterminate status (Sanyal et al., 1993). However, a review of distribution records reveals its occurrence in at least five Indian states. Records from north-eastern Maharashtra and Chhattisgarh further suggest that the species may

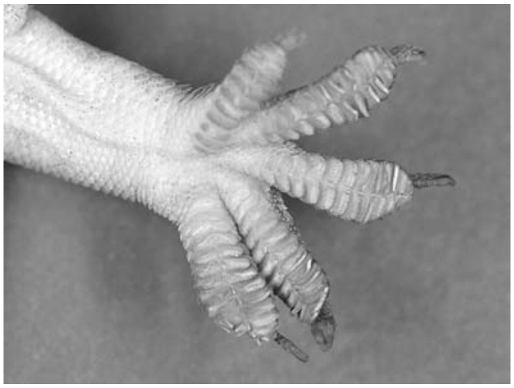

FIGURE 1: Ventral view of left forefoot of *Hemidactylus giganteus* showing varying degrees of lamellar subdivision. Although distal lamellae are divided, some basal lamellae are single or only patially divided.

FIGURE 2: Ventral view of thighs and precloacal region of *H. giganteus* (BNHS 1510) showing the disruption of the femoral pore series on the animal's left thigh.

yet be found in Orissa and/or Madhya Pradesh. In addition to its wide distribution, *H. giganteus* also appears to be abundant at individual sites. This is attested to by our own observations at Basapur as well as those of previous authors (e.g., Stoliczka, 1872; Murthy, 1985). It thus appears that the apparent rarity of *H. giganteus* is an artifact. Despite its large size and high local density, the species has escaped the notice of zoologists and has remained poorly known. This situation parallels that of the golden gecko, *Calodactylodes aureus*, a large, brightly coloured and highly vocal gecko of the Eastern Ghats. Despite its conspicuousness and its occurrence near human settlements, this species was until recently considered one of the rarest of Indian geckos (Bauer and Das, 2001).

Our observations suggest that *Hemidactylus giganteus* is probably chiefly an inhabitant of rock crevices, rather than trees as has been previously reported, or at least that, boulders are one of several habitat types used by the species. Dietary information and details of morphological variation are also provided for the first time. These data, however, are preliminary and it is hoped that additional information on natural history, distribution, and variation will be collected from throughout the range of this large, regionally endemic gecko. Indeed, significant field work is required on most of the geckos of India, as most biological data on this family have been collected from a few widespread and anthropophilic species and are probably not reflective of the group as a whole.

ACKNOWLEDGEMENTS

We are grateful to Ashok Captain, who collected and deposited the specimen in the collection of BNHS, for providing data and reading the manuscript. We are also thankful to Kedar Bhide and Ishan Agarwal for their assistance. At BNHS we are grateful to J. C. Daniel for reading the manuscript, and to Vithoba Hegde, Field Assistant, for curatorial assistance.

LITERATURE CITED

ARORA, G. L. 1962. Biological observations on some termites from Hoshiarpur, Punjab. *In*: Termites in the Humid Tropics. pp: 111-113. UNESCO, Winterthur.

BAUER, A. M. 1990. Phylogenetic systematics and biogeography of the Carphodactylini (Reptilia: Gekkonidae). *Bonner Zool. Monogr*. 30:1-220.

________& I. DAS. 2001. Review of the gekkonid genus *Calodactylodes* (Reptilia: Squamata) from India and Sri Lanka. *J. S. Asian nat. Hist*. 5[2000]: 25-35.

________& A. P. RUSSELL. 1995. The systematic relationships of *Dravidogecko anamallensis* (Günther 1875). *Asiatic Herpetol. Res*. 6: 30-35.

CHOPRA, R. N. 1968. On a new locality and habitat of *Hemidactylus giganteus*. *Sci. & Cult*. 38: 376.

DANIELS, R. J. R. 2000. Reptiles and amphibians of Karnataka. *Cobra* 42: 1-11.

________. 2001. Amphibians and reptiles and amphibians of the Tamil Nadu Eastern and Western Ghats. *Cobra* 43: 1-8.

FRITH, C. B. 1981. Utilization of a single brief termite eruption by predators. *nat. Hist. Bull. Siam Soc*. 29: 173-174.

KLÁTIL, L. 1988. Gekon *Hemidactylus giganteus*. *Akvárium Terárium* 31: 29.

MADRE, V. E. 1978. A redescription of *Trichomitus batrachorum* (Perty, 1852) Honigberg, 1953 from three new hosts in the Marathwada region. *Marathwada Univ. J. Sci., Sec. B, Biol. Sci*. 18: 89-95.

________. 1979. Two species of flagellates of the genus *Chilomastix* Alexeieff, 1912 (Mastigophora: Retortamonadida) from amphibians and reptiles in India. *Acta Protozoologica* 18: 243-250.

MURTHY, T. S. N. 1985. A field guide to the lizards of Western Ghats. *Rec. Zool. Surv. India. Occ. Pap*. (72): 1-51, 14 pls.

________. 1990. A field book of the lizards of India. *Rec. Zool. Surv. India. Occ. Pap*. (115): 1-122.

SANYAL, D. P. & G. DASGUPTA. 1990. On a collection of reptiles from Bastar District, Madhya Pradesh, central India. *Hamadryad* 15: 18-20.

________,________ & N. C. GAYEN. 1993. Reptilia. In: Fauna of Andhra Pradesh. Part 1. (Reptilia, Amphibia, Fishes). pp: 1-63. A. K. Ghosh (Ed). Zoological Survey of India, Calcutta.

SARATCHANDRA, B. 1981. *Proteromonas ganapatii* n. sp. from the wall lizard, *Hemidactylus giganteus*. *Proc. Indian Acad. Parasitol*. 2: 10-12.

SMITH, M. A. 1935. The fauna of British India, including Ceylon and Burma. Reptilia and Amphibia. Vol. II.- Sauria. Taylor and Francis, London. xiii + 440 pp + 1 pl.

SOMAN, P. W. 1966. A new gekkonid in Maharashtra. *Sci. & Cult.* 32: 427.

STOLICZKA, F. 1871. Notes on new or little known Indian lizards. *Proc. Asiatic Soc. Bengal* 1871: 192-195.

________. 1872. Notes on various new or little known Indian lizards. *J. Asiatic Soc. Bengal* 41: 86-135, pls. II-V.

TIKADER B. K. & R. C. SHARMA. 1992. Handbook Indian lizards. Zoological Survey of India, Calcutta. xv + 250 pp., 42 pls.

Received: 9 July 2003.
Accepted: 15 July 2003.

Hamadryad Vol. 27, No. 2, pp. 222 – 240, 2003.

SCOLECOPHIDIA MISCELLANEA

Van Wallach

Museum of Comparative Zoology, Harvard University, Cambridge, MA 02138, USA
Email: vwallach@oeb.harvard.edu

(with one text-figure)

ABSTRACT.– **Various systematic issues of the Typhlopidae and Leptotyphlopidae are discussed, including the taxonomic status of six species (*Typhlops exocoeti* Boulenger, *Onychocephalus acutus* Duméril and Bibron, *Onychocephalus unilineatus* Duméril and Bibron, *Typhlops cumingii mansuetus* Barbour, and *Glauconia natatrix* Andersson), a replacement name for *Typhlops schmidti wilsoni* Laurent, and the terminology of frontal vs. "prefrontal" head shields in the Scolecophidia.**

KEYWORDS.– ***Glauconia natatrix, Onychocephalus acutus, O. unilineatus, Typhlops cumingii mansuetus, T. exocoeti, T. schmidti wilsoni,* prefrontal shield, Typhlopidae, Leptotyphlopidae.**

INTRODUCTION

In order to settle a variety of scolecophidian taxonomic problems that I have noticed, each of which by itself is not worthy of an article, I have assembled them here in one report. This seems to be the easiest way to present the information without having to wait for some future date when a related topic would present itself for consideration.

MATERIALS AND METHODS

Specimens were examined and measurements made under a binocular microscope. Visceral measurements were made to the nearest 0.5 mm with a metric ruler; body and tail measurements, including those of head shields, were made to the nearest 0.1 mm with vernier calipers. Middorsal scales were counted along the vertebral row between but not including the rostral and terminal spine. When only one scale row figure is given, it refers to the midbody count. When three figures are given for the scale rows, the anterior count is made 20 scales posterior to the mental, the middle count at midbody, and the posterior count 10 scales anterior to the vent. Relative rostral width is calculated as the width of the dorsal rostral at its midpoint divided by the head width at the interocular level. Proportional tail length is tail length divided by total length. Relative body width is the total length divided by the horizontal midbody diameter. Relative tail width is tail length from vent to apical spine divided by horizontal midtail diameter. Data for paired organs are presented as left/right.

Descriptions of visceral characters can be found in Wallach (1985, 1993b, 1994, 1995, 1998) and references therein. All visceral data are listed as percent snout-vent length (% SVL, but written as % with the SVL omitted), measured from the anterior tip of the snout (0%) to the vent (100%). The midpoint (MP) of an organ is statistically less variable within a sample than its length, and thus a more reliable systematic character, so organ midpoints are listed in conjunction with the organ lengths. Several terms are used to denote measurements between two organs. A gap is the distance between two organs (caudal tip of anterior organ to cranial tip of posterior organ). The heart-liver gap represents the distance between the heart apex and the anterior tip of the liver, divided by the snout-vent length (e.g., 5%). An interval includes both the gap and the lengths of the two respective organs (cranial tip of anterior organ to caudal tip of posterior organ). Thus, the heart-liver interval is the length from the anterior tip of the heart to the posterior tip of the liver, divided by snout-vent length (e.g., 37%). When two organs or visceral characters are compared, such as the tracheal lung length/right lung length, the value is denoted as a

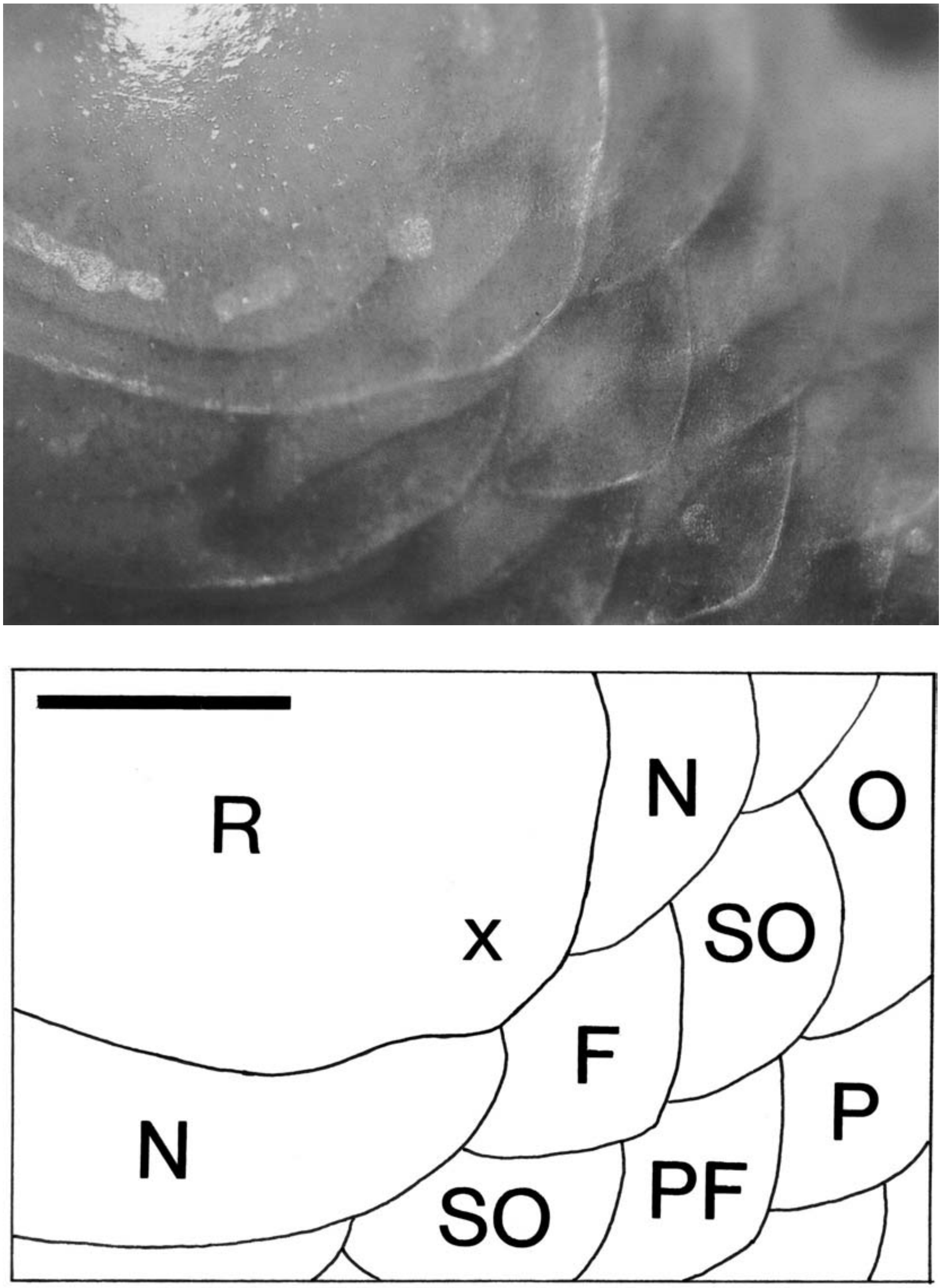

FIGURE 1: Middorsal head region of 144 mm *Rhinotyphlops schlegelii* (TM 13950) showing posterior rostral with retention of colour pattern and gland lines of fused prefrontal. F = frontal, N = nasal, O = ocular, P = parietal, PF = postfrontal, R = rostral, SO = supraocular, x = fused “prefrontal” shield. Bar = 1 mm.

TABLE 1: Comparison of *Ramphotyphlops* vs. *Typhlops* characters in East Indian Typhlopidae. SG = species group (AS = *A. subocularis*, CD = *C. deharvengi*, RA - *R. albiceps*, RB = *R. braminus*, RE = *R. exocoeti*, RF = *R. flaviventer*, RL = *R. lineatus*, RM = *R. multilineatus*, RP = *R. polygrammicus*, TA = *T. ater*, TD = *T. diardii*, TR = *T. ruficaudus*), Area (PNG = Papua New Guinea, SE Asia = south-east Asia), SIP = supralabial imbrication pattern (0 = T-0, II = T-II, III = T-III, V = T-V), SNS = superior nasal suture easily visible dorsally (+ = yes, O = no), RC = rectal caecum length as % SVL (mean, range, sample size), MSR = midbody scale rows, PR = posterior scale row reduction (+ = 2 or more rows, O = none or only 1 row).

Species	SG	Area	SIP	SNS	RC	MSR	PR
R. exocoeti	RE	Christmas Is.	III	+	2.1 (2.0-2.1) 2	20	O
R. albiceps	RA	SE Asia	III	+	2.5 (1.6-2.0) 3	20	O (+)
R. ozakiae	RA	Thailand	III	+	3.8 (3.2-5.2) 6	20	O
R. erycinus	RP	PNG	III	+	6.4 (5.1-7.7) 2	20	O
R. polygrammicus	RP	Indonesia & PNG	III	+	3.9 (2.1-5.3) 5	22	O
R. braminus	RB	Tropicopolitan	III	+	4.0 (2.4-7.4) 12	20	O
R. acuticaudus	RF	Palau Is.	III	O	1.7 (1.3-2.0) 4	22-24	+
R. becki	RF	Guadalcanal	III	O	(absent) 2	22	O
R. depressus	RF	PNG & Solomons	III	O	3.5 (3.0-4.0) 7	22-24	O (+)
R. flaviventer	RF	Maluku & Irian Jaya	III	O	1.7 (1.2-2.1) 7	22	O/+
R. leucoproctus	RF	PNG	III	O	?	20	?
R. similis	RF	Irian Jaya	III	O	?	20	+
R. supranasalis	RF	Irian Jaya	III	O	?	22	+
R. willeyi	RF	Loyalty Is.	III	O	(absent) 1	20	O
R. lineatus	RL	SE Asia & Indonesia	III	O	4.8 (3.0-6.7) 3	22-24	+
R. cumingii	RM	Philippines	III	O	4.2 (3.2-5.4) 3	24-28	+
R. multilineatus	RM	E Indonesia	III	+	4.3 (4.3) 1	20	O
R. olivaceus	RM	Philippines	III	O	3.8 (3.7-3.9) 2	20-22	+
T. conradi	?	Sulawesi	III	+	?	20	O
T. khoratensis	?	Thailand	III	+	5.1 (4.7-5.5) 2	20	O
T. comorensis	?	Comoros	III	O	2.4 (2.4-2.4) 3	22	O/+
T. koekkoeki	?	Borneo	III	O	8.2 (8.2) 1	26	+
T. schmutzi	?	Komodo Is.	V	O	2.3 (1.9-2.6) 2	18-20	O
T. andamensis	TA	Andamans	II	O	?	18	O
T. ater	TA	Indonesia	II	O	1.2 (0.9-1.4) 3	18	O
T. bisubocularis	TA	Java	II	O	1.4 (1.4) 1	18	O
T. depressiceps	TA	PNG	V	O	0.3 (0.3) 1	20-24	+
T. fredparkeri	TA	PNG	II	O	(absent) 1	16	O
T. hedraeus	TA	Philippines	II	O	0.2 (0-0.4) 2	18	O
T. inornatus	TA	PNG	V	O	0.5 (0.2-0.7) 3	20-22	O
T. mcdowelli	TA	PNG	V	O	0.5 (0.5-0.6) 2	22-24	+
T. bothriorhynchus	TD	Malaysia	V	O	?	22-24	+
T. diardii	TD	SE Asia	V	O	3.7 (3.0-4.0) 5	24-28	+
T. hypsobothrius	TD	Sumatra	V	O	?	20	?
T. klemmeri	TD	Malaysia	V	O	?	24	+
T. muelleri	TD	SE Asia & Indonesia	V	O	3.4 (2.4-4.8) 7	24-30	+
T. oatesii	TD	Andamans	V	O	?	24	?
T. trangensis	TD	Thailand	V	O	?	24	+
T. castanotus	TR	Philippines	III	O	(absent) 3	26-28	+
T. collaris	TR	Philippines	III	O	(absent) 2	26-28	+
T. hypogius	TR	Philippines	III	O	?	24	+

T. kraalii	TR	Ceram & Kei Is.	III	O	(absent) 1	24-28	+
T. ruber	TR	Philippines	III	O	0.2 (0-0.5) 3	26	+
T. ruficaudus	TR	Philippines	III	O	(absent) 5	26-30	+
T. suluensis	TR	Philippines	III	O	?	22	+
C. deharvengi	CD	Sulawesi	III	O	3.6 (3.6) 1	22	+
A. infralabialis	AS	Solomons	III	O	(absent) 1	26-28	+
A. kunuaensis	AS	Bougainville Is.	III	O	(absent) 1	30-35	+
A. solomonis	AS	PNG & Bougainville Is.	III	O	(absent) 1	30-34	+
A. subocularis	AS	PNG & Solomons	0	O	(absent) 1	32-36	+

decimal (e.g., 0.75) rather than a percentage in order to differentiate it from the snout-vent length percentages. Distances are lengths from the midpoint of one organ to the midpoint of another, divided by snout-vent length. Organ name without reference to a position refers to the organ length; anterior tip, midpoint, and posterior tip are so indicated. Scolecophidian livers are bilobed and asymmetrical, with one side having an anterior "extension" beyond the other (left side in Typhlopidae, right side in Leptotyphlopidae) and the opposite side forming a posterior liver "tail." Their lengths are expressed as a proportion of total liver length. Kidney overlap is calculated as length of overlap of left and right kidney divided by the kidney-kidney interval.

The islands of Indonesia, the Philippines, and New Guinea plus Malaysia are referred to collectively as the East Indies. Museum acronyms follow Leviton et al. (1985) with the addition of NHCL (New Herpetological Collection Lanza, Firenze, B. Lanza), NUVC (Northeastern University Vertebrate Collection, Boston, G. S. Jones), and TNRC (Thailand National Reference Collection, Bangkok, J. Nabhitabhata).

TAXONOMY

1. Status of *Typhlops exocoeti* Boulenger, 1887

The species described as *Typhlops exocoeti* by Boulenger (1887) was transferred to the genus *Typhlina* Wagler, 1830 (now a synonym of *Ramphotyphlops* Fitzinger, 1843) by Hahn (1980a) and *Ramphotyphlops* by Cogger et al. (1983a). However, Cogger et al. (1983b) questioned the allocation to *Ramphotyphlops* as examination of the only specimen available (AMS 93689), a female, possessed a well-developed left oviduct. Based upon this remark, Greer (1997), without further examination, referred *exocoeti* back to *Typhlops.* This move was supported by Cogger (2000). I was interested in Cogger's remark as two female *R. exocoeti* previously examined (CAS 16867, MCZ 28643) were found to lack the left oviduct. I borrowed AMS 93689 and observed that the right oviduct was well-developed and strongly convoluted whereas there was no trace of a left oviduct. Presumably, due to torsion of the posterior viscera, the right oviduct was mistaken for the left.

Four characters suggest placement of *T. exocoeti* in *Ramphotyphlops:* a T-III SIP, dorsad-extending superior nasal suture that is visible in dorsal view, well developed rectal caecum, and uniform number of scale rows from head to tail (Table 1). Because of its T-III SIP, it more closely resembles *Ramphotyphlops* such as *R. depressus* or *R. flaviventer* than *Typhlops* from the East Indies. East Indian *Typhlops* include the *T. ater* species group with a T-II or T-V SIP, the *T. diardii* species group with a T–V SIP, the *T. ruificaudus* species group with a T-III SIP, and three representatives with a T-III SIP *(T. comorensis, T. conradi,* and *T. koekkoeki). Typhlops comorensis* and *T. conradi* resemble *T. exocoeti* (but differ in number of midbody scale rows and middorsals, respectively) but may be either *Typhlops* or *Ramphotyphlops* as the male genitalia are unknown. *T. koekkoeki* is strongly pigmented dorsally with 26 scale rows and fewer than 300 middorsals; it resembles African *Typhlops* more than any East Indian form.

The only East Indian *Typhlops* with the superior nasal suture extending dorsad unto the top of the snout are *Typhlops conradi* (generic status uncertain) and *T. khoratensis;* however, a num-

ber of *Ramphotyphlops* have this condition (*R. albiceps, R. braminus, R. erycinus, R. multilineatus, R. polygrammicus, R. ozakiae).* The caecum in East Indian *Typhlops* is reduced or vestigial (*T. ater* and *T. diardii* groups) or absent (*T. ruficaudus* group) (McDowell, 1974). The caecum in *R. exocoeti* (2.0-2.1%, n = 2) is intermediate between that of *R. flaviventer* (1.2-2.1%, mean 1.7%, n = 7) and *R. depressus* (3.0-4.0%, mean 3.5%, n = 7) (Wallach, 1998). With the exception of *T. schmutzi* and most of the *T. ater* species group, all East Indian *Typhlops* exhibit posterior scale row reduction whereas most *Ramphotyphlops* do not.

Since a male still has not been examined for hemipenial morphology, the true status of *exocoeti* is unknown. Until a male is examined and shown to possess a *Typhlops*–like hemipenis, this species should be recognized as a member of the genus *Ramphotyphlops.*

2. Status of *Onychocephalus acutus* Duméril and Bibron, 1844

The giant endemic Indian blind snake, *Rhinotyphlops acutus* (Duméril and Bibron, 1844), previously placed in the genus *Typhlops,* was transferred to *Rhinotyphlops* by Wallach (1994) due to its many similarities with members of the African *R. simoni* species group (Group IV of Roux-Estève, 1974). In view of India's long separation from Africa, ca. 120 million years (Sampson et al., 1998), in addition to the morphological differences enumerated below, reconsideration of the status of *R. acutus* is warranted.

Rhinotyphlops acutus differs from other members of *Rhinotyphlops* in the following characters: 1) lateral tongue papillae (vs. no tongue papillae), 2) hooked "beak" and concavity on ventral rostral (vs. flat or anteriorly projecting cutting edge), 3) subocular larger than preocular (vs. smaller or absent), 4) nasal barely wider than ocular, preocular and subocular (vs. much wider than at least preocular), 5) frontal less than 1/3 width of rostral (vs. as wide as or wider than rostral), 6) 24-34 midbody scale rows (vs. 18-24 in most species, only *R. newtoni* with 26-28 midbody rows and *R. somalicus* with 24-30 midbody rows), 7) posterior scale row reduction of 4-6 rows (vs. no scale row reduction or only 2 rows, rarely 4 rows, posteriorly), 8) unipartite testes (vs. multipartite testes), 9) triradiate Y-shaped pelvic remnant composed entirely of cartilage (vs. single I-shaped or J-shaped structure made of bone or bone and cartilage), 10) broad rostral, relative rostral width 0.80-0.82 (vs. 0.51-0.71), 11) highly segmented liver, mean number of total segments 41.0 (vs. 11.9), and 12) adrenals elongate in shape, 3 times as long as broad (vs. oval, nearly as broad as long).

Rhinotyphlops acutus (n = 3) differs from all other *Rhinotyphlops* (n = 104) in the following visceral characters (mean values as % SVL, *R. acutus* first, other *Rhinotyphlops* spp. second): hyoid posterior tips (5.8 vs. 11.1), gall bladder-gonad gap (11.8 vs. 1.8), total gonad midpoint (82.4 vs. 75.1), total adrenal midpoint (87.7 vs. 76.3), total kidney midpoint (95.0 vs. 85.9), kidney-vent gap (2.2 vs. 11.4), kidney-vent interval (8.1 vs. 16.8), rectal caecum-vent interval (9.0 vs. 20.2), total tracheal rings (405.2 vs. 303.5), and the following intervals between organ means: trachea-adrenal (70.7 vs. 59.1), heart-kidney (63.9 vs. 54.9), liver-kidney (45.9 vs. 37.0), trachea/bronchus-kidney (75.4 vs. 66.0), and right lung-adrenal (45.6 vs. 33.0). In addition to the above, *R. acutus* (n = 3) differs from the phenotypically similar *R. caecus* species group (n = 56) in the following visceral characters (mean values as % SVL, *R. acutus* first, other *R. caecus* group second): heart midpoint (31.1 vs. 26.5), total liver midpoint (48.2 vs. 41.9), liver-gall bladder gap (3.9 vs. 9.8), and rectal caecum/heart length (0.54 vs. 1.03).

W. Peters (1881) established the genus *Grypotyphlops* with *Onychocephalus acutus* Duméril & Bibron designated as the type species. Since the name is available, *O. acutus* is returned to *Grypotyphlops* Peters. The species currently known as *Rhinotyphlops acutus* (Duméril and Bibron) should now be referred to as *Grypotyphlops acutus* (Duméril and Bibron).

3. Status of *Onychocephalus unilineatus* Duméril and Bibron, 1844

Typhlops unilineatus (Duméril and Bibron, 1844), supposedly sent to Paris by Mme. Richard née Rivoire from "Cayenne, French Guiana," is still known only from the type specimen (MNHN 1064). Despite extensive collecting in the region of Cayenne and the Guianas, further specimens have not been found; its peculiar morphology precludes it being a Neotropical typhlopid. Dixon and Hendricks (1979) suggested that *T. unilineatus* did not originate from South America and that it may be related to the *T. diardii* group of Indonesia. Examination of the type reveals that it is greatly deteriorated with the head partially eaten away, heart protruding, much of the skin missing with musculature visible. It has 30-28-27 scale rows (Duméril and Bibron reported 26 midbody rows), approximately 485 middorsals (based on the existing 379 dorsals that cover 78% of the total length), 12 subcaudals, snout-vent length 291.5 mm, tail 4.5 mm, proportional tail length 1.5% (Duméril and Bibron reported 2.0%), midbody diameter 6.0, relative body width 49.3 (Duméril and Bibron reported 50), relative tail width 1.5; head narrower than neck, snout bluntly rounded in dorsal aspect; dorsal rostral broad and parallel with a weak narrow anterior cutting edge (at 45° angle); frontal small, ca. one-half the width of rostral; parietals transverse and twice the width of costals; enlarged occipitals lacking; snout convex in lateral view with sharp edge anteriorly, ventral rostral flat; nasal larger than preocular and ocular, which are subequal to one another; nasals at least semidivided, with inferior nasal suture contacting second supralabial; well-developed eye with pupil beneath middorsal portion of ocular shield; postoculars 3, possibly 4 if lowermost one is missing (partly dependent upon how large the fourth supralabial was); all supralabials except the first are missing, supralabial imbrication pattern presumably T-0; apical spine apparently absent; no indication of lateral tongue papillae; maxilla with 5 teeth; dorsum and venter dark brown with a thin black vertebral line; posterior tip of heart at 36.0%.

All of the above characteristics, except absence of lateral tongue papillae and eye beneath the ocular, agree with those of *Grypotyphlops acutus.* Due to the poor state of preservation of *O. unilineatus,* it cannot be confirmed that the lingual papillae are lacking; it is possible that the papillae were previously present but not apparent due to the deterioration of the soft tissues. The presence of a visible eye beneath the ocular remains the only solid difference between the two taxa. The heart tip in *G. acutus* (n = 3) ranges from 31.3-34.6%. Until additional specimens are discovered that suggest otherwise, I suggest placing *Onychocephalus unilineatus* Duméril and Bibron in the synonymy of *Grypotyphlops acutus* (Duméril and Bibron); the type locality of "Cayenne" is thus in error as previous authors have suggested.

4. Status of *Typhlops cumingii mansuetus* Barbour, 1921

Barbour (1921) described a new subspecies of *Typhlops cumingii* from the Solomon Islands without providing morphological data, although two excellent illustrations (pl. 6) were provided. His comparison was limited to a mention of the similarity of the two forms with the exception of "fine warty excrescences on the snout" and the absence of the "narrow, subcrescentic, sharp, transverse edge" present in *T. cumingii;* also mentioned were the wider rostral and larger prefrontal of *T. c. mansuetus* in comparison with *T. cumingii.* Were it not for the excellent figures, the validity of Barbour's description might be questioned.

McDowell (1974) examined, described and refigured the type (fig. 12) and placed Barbour's form in the synonymy of *Typhlina* (currently *Ramphotyphlops*) *affinis* (Boulenger, 1889), to which it is obviously related. It remains a mystery as to how this snake could have been considered conspecific with *Typhlops cumingii.*

The Solomon Island population can clearly be separated from the Australian population of *R. affinis* as demonstrated by the following selected characters *(R. mansuetus* data first, *R. affinis* data second): 1) middorsal scale count (333-397 vs. 445-503), 2) ventral rostral (angled vs. horizon-

tal), 3) eye (faint eyespot vs. eye with distinct pupil, 4) frontal (twice as broad as deep vs. as deep as broad), 5) supraocular orientation (transverse vs. oblique), 6) ocular-preocular size (equal vs. ocular larger than preocular), 7) tracheal lung type (paucicameral with 33 niches vs. multicameral with 30-46 chambers), 8) cardiac lung type (unicameral vs. paucicameral with 3-4 chambers), and 9) right lung type (unicameral vs. paucicameral with 2-5 chambers). Additionally, there appears to be a size difference as the maximum length in two adult specimens of *R. mansuetus* is 159 mm whereas *R. affinis* reaches 320 mm (Ehmann, 1992). Although confirmation of generic status is lacking due to absence of an available male, this species is considered a *Ramphotyphlops* based on resemblance to *R. affinis* and geography, since the only known *Typhlops* east of the Papua New Guinea mainland is *T. depressiceps* from Kiriwina Island (McDowell, 1974; Wallach, 1995; O'Shea, 1996). Barbour's taxon is therefore resurrected from the synonymy of *R. affinis* and recognized as a valid species. *Ramphotyphlops mansuetus* (Barbour) is known only from San Cristóbal (MCZ 14270) and Bougainville (MCZ 92527) Islands but it could be present on any of the intervening islands such as Choiseul, Santa Isabel, New Georgia, or Guadalcanal.

5. Status of *Glauconia natatrix* Andersson, 1937

A most peculiar species of *Leptotyphlops* was described under the name of *Glauconia natatrix* by Andersson (1937). This new species was reported to possess several unique features for members of the Leptotyphlopidae: three supralabials, semidivided nasal, and depressed oarlike tail. The flattened tail, even though compressed dorsoventrally rather than laterally as in aquatic and sea snakes, was suggested as evidence that this species resembled a miniature sea snake and was an adept swimmer. The holotype was collected in the Tobo Swamp on McCarthy Island, The Gambia, in 1931, lending support of the aquatic habits of this creature. The species has never been illustrated and no further specimens of this taxon have been collected or reported in the literature so it remains known only from the holotype (Hahn, 1980a; McDiarmid et al., 1999).

Examination of the holotype of *Glauconia natatrix* (NRM 5490, previously ZI R797), which is soft and poorly preserved, shows it to have the following characters: snout-vent length 119.0 mm, tail length 14.0 mm, total length 133.0 mm, proportional tail length 10.5%, midbody diameter 2.2 mm, relative body width 60.5, midtail diameter 2.0 mm, relative tail width 7.0; total middorsals 290 (292 *fide* Andersson), subcaudals 33 (35 *fide* Andersson), 14-14-14 scale rows, midtail scale rows 10; head narrower than neck and tapered in dorsal view, dorsal snout profile rounded with large sagittate rostral, subtriangular in configuration, relative rostral width 0.63; frontal, supraoculars, and postfrontal all small and subequal in size; parietals and occipitals transversely enlarged, occipitals 3/4 the width of parietals; lateral head profile with weak rostral beak, separated from mouth ventrally by a preoral concavity; nasals divided (semidivided *fide* Andersson) into small vertical infranasals and large supranasals, the latter nearly meeting along midline, barely separated by rostral apex; nostril centered along internasal suture; supralabials 2 (3 *fide* Andersson); anterior supralabial short, less than half as tall as the infranasal but twice its width along lip border; posterior supralabial short, not reaching level of eye, and more than twice as broad as anterior supralabial along lip border; eye moderate in size with discernible pupil, located in center of ocular shield near supraocular border; infralabials 4; cloacal shield oval or semilunate-shaped; tail not naturally compressed, only the posterior half flattened dorsoventrally as if run over by a vehicle (bicycle?) or trod upon by a person or hoofed animal; apical spine reduced to a short nubbin; general colouration pink with faint brown pigmentation on 3-5 middorsal scale rows, venter immaculate pink.

It is apparent that the flattened tail of *Glauconia natatrix* is a result of some physical trauma and not a natural aquatic derivation as

seen in hydrophiids, laticaudines, and certain aquatic snakes like *Boulengerina,* some homalopsines and a few natricines, all of which have the compression occurring laterally, assisted by the extension of the neural spines and haemapophyses of the caudal vertebrae. It was not necessary to x-ray this specimen to see that no such caudal projections were present: the tail abruptly changed from a typically cylindrical shape at the base to a completely flattened shape at the midtail region, exactly as if it had been run over by a bicycle or crushed by a boot.

Generally all snakes have the ability to swim as the most common terrestrial locomotory motion, lateral undulation, is identical to that used in swimming. Scolecophidians are no exception this rule, and while they are mainly fossorial or semifossorial in habits, they also are arboreal at times (Das and Wallach, 1998) and have often been found swimming after heavy rains or flooding. However, it defies the imagination to envision what selective pressures could possibly result in a snake that feeds upon the larvae and eggs of ants and termites becoming aquatic.

Although a few species of *Leptotyphlops* (the *L. macrolepis* species group of tropical America and *L. bicolor, L. broadleyi,* and *L. sundewalli* of Africa) do have three supralabials, such is not the case (on either side of the head) in *Glauconia natatrix.* It can only be surmised that Andersson unintentionally interpreted the infranasal as the first supralabial.

In contrast to African *Typhlops,* in which most species have a semidivided nasal, all specimens of *Leptotyphlops* examined thus far have a completely divided nasal shield. A semidivided nasal has been reported in the literature (i.e., *Leptotyphlops cairi, L. sundewalli* and others *fide* Jan, 1864) but this condition has not been confirmed recently. It is quite possible that the incompletely divided nasal condition was the result of poor optics.

The only known Leptotyphlopidae occurring in extreme West Africa (Sénégal, The Gambia, and Guinea-Bissau) are *Rhinoleptus koniagui, Leptotyphlops boueti,* and *L. macrorhynchus* (Villiers, 1975). *Rhinoleptus koniagui* differs from all *Leptotyphlops* in having 16 scale rows throughout the body and an acutely pointed snout. *Leptotyphlops boueti* differs from *Glauconia natatrix* in having a head that is broader than the neck, reduced eye, rostral that is narrower and nearly parallel, lack of enlarged occipitals, and a stout terminal spine. A comparison of the holotype of *Glauconia natatrix* with *Leptotyphlops macrorhynchus* reveals that the data of the former fall within the range of the latter, as follows (*L. natatrix* data first, *L. macrorhynchus* second): total length (133 mm vs. 115-293 mm), middorsals (290 vs. 297-492), subcaudals (33 vs. 26-48), length/width ratio (60.5 vs. 49-143), relative tail length ratio (10.5 vs. 6.0-12.7), relative tail width ratio (7.0 vs. 7.2-11.0), rostral shape, rostral beak and preoral

TABLE 2: Chronological terminology used for the first two middorsals (MD) in the Anomalepididae.

Authority	Genus	1st MD	2nd MD
Boulenger, 1893	Helminthophis	frontal	
Amaral, 1924	Helminthophis	frontal	
Taylor, 1939b	Anomalepis	frontal	postfrontal
Dunn, 1944	Helminthophis, Liotyphlops	frontal	postfrontal
Roze, 1952, 1966	Helminthophis, Liotyphlops	frontal	
Peters & Orejas-Miranda, 1970	Anomalepis, Helminthophis, Liotyphlops	frontal	
Dixon & Kofron, 1984	Liotyphlops	frontal	postfrontal
Kofron, 1988	Anomalepis	frontal	
Pérez-Santos & Moreno, 1988	Anomalepis, Helminthophis, Liotyphlops	frontal	
Wallach & Günther, 1997	Liotyphlops	frontal	postfrontal
Savage, 2002	Anomalepis, Helminthophis, Liotyphlops	frontal	

TABLE 3: Chronological terminology used for the first four middorsals (MD) in the Typhlopidae and Leptotyphlopidae.

Authority	1st MD	2nd MD	3rd MD	4th MD
Duméril & Bibron, 1844	anterior frontal	frontal	interparietal	
Gray, 1845	internasal	frontal	interparietal	
Duméril, A.H.A., 1856	prefrontal	frontal	interparietal	
Gunther, 1864	prefrontal	frontal	interparietal	
Peters, 1865, 1882	nasofrontal			
Stoliczka, 1871	prefrontal	frontal	interparietal	
Gasman, 1884	prefrontal	frontal		
Boulenger, 1890, 1912	prefrontal	frontal	interparietal	
Cope, 1900	frontal			
Stejneger, 1904, 1907	prefrontal	frontal	interparietal	
Waite, 1918, 1929	prefrontal	frontal	interparietal	
Wall, 1918, 1921	prefrontal	frontal	interparietal	
Taylor, 1922, 1939a, 1947, 1965	prefrontal	frontal	interparietal	
Brongersma, 1934	prefrontal	frontal	interparietal	nuchal
Klauber, 1940	prefrontal	frontal	interparietal	interoccipital
Schmidt & Davis, 1941	prefrontal	frontal	interparietal	interoccipital
Smith, 1943	prefrontal	frontal		
Dunn, 1944	frontal			
Kinghorn, 1948	prefrontal	frontal	interparietal	
Leeson, 1950	prefrontal	frontal		
Villiers, 1950b, 1963b, 1975	frontal			
Stebbins, 1954	prefrontal	frontal	interparietal	interoccipital
Deraniyagala, 1955	prefrontal	frontal	interparietal	
Laurent, 1956, 1964	prefrontal	frontal		
Roze, 1952, 1966	frontal			
FitzSimons, 1962	prefrontal	frontal		
Worrell, 1963	prefrontal	frontal	interparietal	
Orejas-Miranda, 1964, 1967, 1969	prefrontal	frontal	interparietal	interoccipital
Fowlie, 1965	prefrontal	frontal	interparietal	interoccipital
Peters & Orejas-Miranda, 1970	frontal			
Broadley, 1971	prefrontal	frontal		
Saint Girons, 1972	prefrontal	frontal	interparietal	
Orejas-Miranda & Zug, 1974	prefrontal	frontal	interparietal	inbteroccipital
Roux-Estève, 1974, 1975, 1980	frontal			
Murphy, 1975	prefrontal			
Broadley & Watson, 1976	prefrontal	frontal	interparietal	interoccipital
Hoogmoed, 1977	prefrontal	frontal	interparietal	interoccipital
Orejas-Miranda et al., 1977	prefrontal	frontal	interparietal	interoccipital
Hahn, 1979, 1980b	prefrontal	frontal		
Roux-Estève, 1979	prefrontal	frontal	interparietal	
Silva, 1980	prefrontal	frontal	interparietal	
Mahendra, 1984	prefrontal	frontal	interparietal	
Villa, 1988	prefrontal			
Broadley & Howell, 1991	prefrontal	frontal	interparietal	interoccipital
Broadley, 1988, 1999	prefrontal	frontal	interparietal	interoccipital

Pérez-Santos & Moreno, 1988, 1991	frontal			
Meirte, 1992	prefrontal	frontal	interparietal	
Wynn & Leviton, 1993	prefrontal	frontal	interparietal	
Wallach, 1994, 1995, 1996, 2001	frontal	interparietal	interoccipital	
O'Shea, 1996	prefrontal	frontal		
Wallach & Ineich, 1996	prefrontal			
Broadley & Wallach, 1997	prefrontal (fused)	frontal	interparietal	
Wallach, 1997	prefrontal	frontal	postfrontal	interparietal
Hahn & Wallach, 1998	prefrontal	frontal		
Broadley & Broadley, 1999	prefrontal	frontal	interparietal	
Niyomwan, 1999	prefrontal	frontal	1st interparietal	2nd interparietal
Wallach, 1999	prefrontal	frontal		
Broadley & Wallach, 2000	frontal			
Savage, 2002 (Typhlopidae)	frontal			
Savage, 2002 (Leptotyphlopidae)	prefrontal			
Wallach, 2003	frontal	postfrontal		
Broadley, Doria & Wigge, 2003	frontal	postfrontal	interparietal	interoccipital

concavity, eye size, size of supralabials, dorsal scale rows, midtail scale rows, and colouration.

Leptotyphlops macrorhynchus is known from various localities in West Africa: Morocco (Bons and Geniez, 1996), Algeria, Tunisia, Libya, Mauritania (Villiers, 1952a-b; Le Berre, 1989), Sénégal, Guinea (Villiers, 1954), Mali (Villiers, 1950a), Burkina Faso (Roman, 1980), and Chad (Villiers, 1963a). A revision of the *L. macrorhynchus* species group is currently underway (Broadley and Wallach, unpubl.) and preliminary results indicate that the North African, West African, and Asian populations are not conspecific with the north-eastern African *L. macrorhynchus,* the type locality of which is in the Sudan. Several populations have already been described (*L. algeriensis* in Algeria, *L. bilmaensis* in Niger, *L. braccianii* and *L. erythraeus* in Eritrea, *L. phillipsi* in Jordan, *L. hamulisrostris* in Iran) that may be valid. It is quite likely that *Glauconia natatrix* represents a distinct population of the *L. macrorhynchus* group, in which case the name would remain valid (even though etymologically inappropriate). Until the *L. macrorhynchus* situation is sorted out, I place *L. natatrix* in the *L. macrorhynchus* species group as *Leptotyphlops* cf. *macrorhynchus.*

6. Replacement name for *Typhlops schmidti wilsoni* Laurent, 1968

Laurent (1968) described a new subspecies of *Typhlops schmidti,* naming it after the collector V. J. Wilson, based on a series of three specimens from Mkanda, Zambia. The taxon was later listed by Broadley (1971), Roux-Estève (1974), Hahn (1980a), and McDiarmid et al. (1999). Unfortunately, the name is preoccupied by *Typhlops wilsoni* Wall (1908), also named for its collector Lt. A. T. Wilson, which is known only from the missing holotype collected in Maidan Mihaftan, Iran. Both Hahn (1980a) and McDiarmid et al. (1999) noted that Laurent's name was preoccupied but no action was taken to resolve the situation. Roux-Estève (1974) did not recognize *Typhlops schmidti* as a valid species and placed it

TABLE 4: Chronological terminology used for the first four middorsals (MD) in *Acutotyphlops*.

Authority	1st MD	2nd MD	3rd MD	4th MD
Kinghorn, 1948	frontorostral	frontal	parietal	
Peters, 1948	frontal	postfrontal	parietal	
Wallach, 1995	frontorostral	frontal	postfrontal	interparietal

in the synonymy of *T. lineolatus lineolatus.* However, other researchers have recognized it (Hahn, 1980; Wallach, 1998; McDiarmid et al., 1999). Broadley and Wallach (2000) transferred *Typhlops angolensis* and the *T. punctatus* species group to *Rhinotyphlops* Fitzinger, 1843; thus *Typhlops schmidti* is now known as *Rhinotyphlops schmidti.* I take this opportunity to propose a replacement name for *Typhlops schmidti wilsoni* Laurent by suggesting *Rhinotyphlops schmidti laurenti* nom. nov. in honour of the original describer.

8. Terminology of anterior middorsal head shields

In anomalepidids the first middorsal shield on the dorsum of the head immediately posterior to the rostral and bordered laterally by the supraoculars has always been termed the frontal (Table 2). In typhlopids and leptotyphlopids, however, the first middorsal shield has usually been called the prefrontal, followed by the frontal, interparietal, and interoccipital (Table 3). This terminology is incorrect and inconsistent with the homology of head shields in alethinophidian snakes. The first middorsal has been correctly labelled as the frontal in all three families by certain authors (Table 3). In *Acutotyphlops,* which has fragmentation of the typical typhlopid head shields, the second middorsal occupies the same position as the first middorsal in most other scolecophidians (i.e., between the eyes or oculars) (Table 4). Kinghorn (1948), who listed the first two middorsals of typical *Typhlops* as the prefrontal and frontal, labelled the second middorsal "the frontal between the eyes" in his new species *Typhlops keasti* (= *Acuotyphlops subocularis*). There has been little consistency in the usage of the terminology in multiple publications by a single author. I therefore make a plea for nomenclatural standardization of the first five middorsals in scolecophidians as follows: frontal, postfrontal, interparietal, interoccipital, and nuchal.

In alethinophidians, three shields are present on the dorsum of the head between the eyes, a median frontal bordered laterally by a pair of supraoculars, and these shields correspond to the bones that they cover. An identical situation exists in most scolecophidians: three shields are normally present between the ocular shields. The orbits in the skull of all scolecophidians are separated by paired frontal bones. Anterior to the frontals the dorsal snout consists of the paired nasals with the prefrontals positioned laterally (List, 1966). The lateral position of the prefrontal bone corresponds to the position of the prefrontal shield in the Anomalepididae (Haas, 1964, 1968). The divided nasal shields are lateral in position (and hence more properly termed prenasal and postnasal) with the prenasal in contact with the rostral. The paired prefrontal shields lie dorsal to the nasals but are separated medially by the enlarged rostral. The azygous frontal borders the rostral caudally and is separated from the oculars and bordered laterally by the supraoculars. In most Typhlopidae and Leptotyphlopidae the rostral shield covers the premaxillary and nasal bones whereas the supranasal shields (= fused postnasal-prefrontal) cover the prefrontal bones.

Prefrontal bones and shields are paired elements in all snakes. The arrangement of head shields in the Anomalepididae is reminiscent of that of most Colubroidea. Three of the four genera of anomalepidids possess large discrete, prefrontal shields: in *Anomalepis* they are dorsal, very large, and alethinophidian-like; in both *Helminthophis* and *Liotyphlops* they are large and lateral; in *Typhlophis* they are small and difficult to distinguish from adjacent scales (Peters and Orejas-Miranda, 1970). The retention of discrete prefrontals is considered a plesiomorphic condition because the Anomalepididae is considered by some to be the most primitive of the three scolecophidian families (Underwood, 1967; McDowell, 1987; Shine, 1991; Pough et al., 1998).

In all scolecophidian genera except *Typhlophis* there are three shields between the oculars or eyes, as in most alethinophidians. Even *Cyclotyphlops* has three large shields between the oculars (although the frontal is circular). The homology of these shields suggests that the shield in scolecophidians between the supraoculars and behind the rostral is the frontal, not the prefrontal. In those species having a me-

dian shield between the frontal and rostral (i.e., *Acutotyphlops* spp.), it has been termed the frontorostral (Table 4). Accepting this, the following middorsal shields would be the frontal, postfrontal, interparietal, and interoccipital. For anyone wishing to consider the middorsal anterior to the true frontal as an azygous prefrontal, it can be seen that in a juvenile *Rhinotyphlops schlegelii* such a shield has already fused with the rostral (Fig. 1). In older specimens of *R. schlegelii* all traces of a separate shield have disappeared. Remnants of this fusion can be seen in many typhlopids and leptotyphlopids, the telltale signs being evident by the shape, colouration, or gland line disposition of the posterior rostral.

The presumed evolutionary transition in both the Typhlopidae and Leptotyphlopidae has involved fusion of the prefrontals with the postnasal, forming a large supranasal extending onto the dorsum of the head (Dunn, 1944; Peters and Orejas-Miranda, 1970; Pérez-Santos and Moreno, 1988, 1991; Savage, 2002). Comparison of fossorial squamates with their nearest terrestrial relatives demonstrates a tendency for fusion of head shields in burrowing forms and, at least in African typhlopids, there is a correlation of head shield fusion with degree of fossoriality (Roux-Estève, 1974). One apparent evolutionary trend in the Scolecophidia is the enlargement of the rostral dorsally (in width and length) by fusion with adjacent shields, a process that is paralleled in many burrowing squamates in conjunction with strengthening of the snout. The extreme extent of this is seen several *Rhinotyphlops* species where the rostral covers most of the head and extends far posterior to the level of the eyes, having fused with the frontal and one or more scales behind it as in *R. praeocularis* with the extreme in rostral development seen in *R. scorteccii.* Presumably the most primitive rostral condition is seen in a few species with a narrow and short rostral followed by a discrete frontorostral and frontal, such as *Typhlophis squamosus* and the four *Acutotyphlops* species.

A further fusion of the first supralabial with the infranasal and the third supralabial with the ocular may have resulted in the typical *Leptotyphlops* condition of only two supralabials. Exceptions to only two supralabials are found in the African *L. sundewalli* and Neotropical *L. macrolepis* groups (both of which have the anterior supralabial vertically divided to produce three supralabials) and the Caribbean *L. bilineatus* group (which has the ocular divided horizontally to produce one or two additional small supralabials). Other apparent fusions include the supraocular with the ocular in *L. humilis* and the *L. borrichianus* species group and the frontal with the rostral in *L. ater* and the *L. labialis* and *L. scutifrons* species groups.

ACKNOWLEDGMENTS

I wish to acknowledge the curators and staff who have kindly loaned material for examination: C. W. Myers and L. Ford (AMNH); A. E. Greer and R. Sadlier (AMS); E. N. Arnold, B. Clarke, and C. J. McCarthy (BMNH); C. Kishinami (BPBM); J. W. Sites, Jr., and S. Skidmore (BYU); R. C. Drewes, A. E. Leviton, and J. V. Vindum (CAS); C. J. McCoy, Jr., J. Wiens, E. J. Censky, and S. Rogers (CM); H. K. Voris, H. Marx, R. F. Inger and A. Resetar (FMNH); N. Sivan and Y. L. Werner (HUJ); G. Lenglet and M. Lang (IRSNB); W. E. Duellman and C. J. Raxworthy (KU); D. A. Rossman, J. Boundy, and F. T. Burbrink (LSUMZ); E. E. Williams, J. Hanken, and J. P. Rosado (MCZ); V. Mahnert, B. Schätti, and J. Mariaux (MHNG); I. Ineich (MNHN); E. Banfi, S. Scali, M. Podestà, and S. Bardelli (MSNM); H. W. Greene (MVZ); M. Poggesi, B. Lanza, and A. Nistri (MZUF); B. Lanza (NHCL); S. O. Kullander (NHRM); B. Schätti and E. Kramer (NMBA); F. Tiedemann and H. Grillitsch (NMW); D. G. Broadley and S. Broadley (NMZB and NMZB-UM); A. J. Coventry (NMV); G. S. Jones (NUVC); W. R. Branch (PEM); I. Bigilale (PNGM); J. A. Covacevich and P. J. Couper (QM); R. W. Murphy (ROM); B Hollingsworth (SDSNH); A. Bogadek (SLS); G. Köhler and M. Laudahn (SMF); H. Mendelssohn (TAU); W. D. Haacke and M. Burger (TM); J. Nabhitabhata (TNRC); D. L. Auth and W. Auffenberg (UF); R. A. Nussbaum, C. J. Raxworthy, and A. G. Kluge (UMMZ); J. Menzies (UPNG); G. R. Zug and A.

H. Wynn (USNM); W. Böhme (ZFMK); L. van Tuijl (ZMA); R. Günther (ZMB); H.-W. Koepcke and J. Hallermann (ZMH); J. B. Rasmussen (ZMUC); F. Glaw and M. Franzen (ZSM).

Thanks are also due to A. H. Wynn for an excellent review that precipitated much improvement in the manuscript and to A. Schulze for taking the photograph of *Rhinotyphlops schlegelii*.

LITERATURE CITED

AMARAL, A. DO. 1924. *Helminthophis*. *Proc. New England Zool.* Club 9: 25-30.

ANDERSON, L. G. 1937. Reptiles and batrachians. Collected in the Gambia by Gustav Svensson and Birge Rudebeck. *Arkiv Zool.* 29A: 1-28.

BARBOUR, T. 1921. Reptiles and amphibians from the British Solomon Islands. *Proc. New England Zool. Club* 7: 91-112.

BONS, J. & P. GENIEZ. 1996. Amphibians & reptiles of Morocco (including Western Sahara): biogeographical atlas. Asociación Herpetológica Española, Barcelona. 320 pp.

BOULENGER, G. A. 1887. III. Reptiles. In: Report on a zoological collection made by the officers of H.M.S. 'Flying-Fish' at Christmas Island, Indian Ocean. A. C. L. G. Günther (Ed). *Proc. Zool. Soc. London* 1887: 516-517.

________. 1889. Descriptions of new Typhlopidae in the British Museum. *Ann. Mag. nat. Hist.,* ser. 6, 4: 360-363.

________. 1890. The fauna of British India, including Ceylon and Burma. Reptilia and Batrachia. Taylor and Francis, London. xviii + 541 pp.

________. 1893. Catalogue of the snakes in the British Museum (Natural History). Volume I. British Museum (Natural History), London. xiii + 448 pp + Pl. I-XXVIII.

________. 1912. A vertebrate fauna of the Malay Peninsula from the Isthmus of Kra to Singapore, including the adjacent islands. Reptilia and Batrachia. Taylor and Francis, London. xiii + 294 pp.

BROADLEY, D. G. 1971. The reptiles and amphibians of Zambia. *The Puku* 6: 1-143.

________. 1988. A check list of the reptiles of Zimbabwe, with synoptic keys. *Arnoldia* Zimbabwe 9: 369-430.

________. 1999. A new species of worm snake from Ethiopia (Serpentes: Leptotyphlopidae). *Arnoldia* Zimbabwe 10: 141-144.

________& S. BROADLEY. 1999. A review of the African worm snakes from south of Latitude 12°S (Serpentes: Leptotyphlopidae). *Syntarsus* 5: 1-36.

________& K. M. HOWELL. 1991. A checklist of the reptiles of Tanzania, with synoptic keys. *Syntarsus* 1: 1-70.

________& V. WALLACH. 1997. A review of the worm snakes of Mozambique (Serpentes: Leptotyphlopidae) with the description of a new species. *Arnoldia Zimbabwe* 10: 111-119.

________& V. WALLACH. 2000. A new blind snake (Serpentes: Typhlopidae) from montane forest of the Eastern Arc Mountains in Tanzania. *African J. Herpetol.* 49: 165-168.

________& G. WATSON. 1976. A revision of the worm snakes of south-eastern Africa (Serpentes: Leptotyphlopidae). *Occ. Pap. Nat. Mus. Mon. Rhodesia* 5B: 465-510.

________, C. T. DORIA & J. WIGGE. 2003. Snakes of Zambia. Edition Chimaira, Frankfurt am Main. 266 pp.

BRONGERSMA, L. D. 1934. Contributions to Indo-Australian herpetology. *Zool. Meded.* 17: 161-251.

COGGER, H. G. 2000. Reptiles & amphibians of Australia. Reed New Holland, Sydney. 808 pp.

________, E. E. CAMERON & M. COGGER. 1983a. Zoological catalogue of Australia. Volume 1. Amphibia and Reptilia. Australian Government Publ. Serv., Canberra. 313 pp.

________, R. SADLIER & E. CAMERON. 1983b. The terrestrial reptiles of Australia's island territories. *Australian Nat. Parks & Wildlife Serv., Spec. Publ.* 11: 1-80.

COPE, E. D. 1900. The crocodilians, lizards, and snakes of North America. *Ann. Rep. U.S. Nat. Mus.* 1898: 155-1294 + Pl. 1-36.

DAS, I. & V. WALLACH. 1998. Scolecophidian arboreality revisited. *Herpetol. Rev.* 29: 15-16.

DERANIYAGALA, P. E. P. 1955. A colored atlas of some vertebrates from Ceylon. Volume three. Serpentoid Reptilia. Government Press, Colombo. 121 pp + Pl. I-VII + Pl. 36-49.

DIXON, J. R. & F. S. HENDRICKS. 1979. The wormsnakes (family Typhlopidae) of the Neotropics, exclusive of the Antilles. *Zool. Verhand.* 173: 1-39.

________& C. P. KOFRON. 1984. The Central and South American anomalepid snakes of the genus *Liotyphlops*. *Amphibia-Reptilia* (1983), 4: 241-264.

DUMÉRIL, A. H. A. 1856. Note sur les reptiles du Gabon. *Rev. Mag. Zool.,* sér. 2, 8: 369-377, 417-424, 460-470, 553-562.

DUMÉRIL, A. M. C. & G. BIBRON. 1844. Erpétologie générale ou histoire naturelle complète des reptiles. Tome sixième, comprenant l'histoire génerale des ophidiens, la description des genres et des espèces de serpents non venimeux, savoir: la totalité des vermiformes ou des scolécophides. et partie des cicuriformes ou azémiophides; en tout vingt-cinq genres et soixante-cinq espèces. Librairie Encyclopédique de Roret, Paris. xii + 609 pp.

DUNN, E. R. 1944. A review of the Colombian snakes of the families Typhlopidae and Leptotyphlopidae. *Caldasia* 3: 47-55.

EHMANN, H. 1992. Encyclopedia of Australian animals: reptiles. Angus & Robertson, Pymble. xv + 495 pp.

ESSEX, R. 1927. Studies in reptilian degeneration. *Proc. Zool. Soc. London* 1927: 879-945.

FITZINGER, L. J. F. J. 1843. Systema reptilium. Fasciculus primus. Amblyglossae. Braumüller et Seidel Bibliopolas, Vindobonae. vi + 106 pp.

FITZSIMONS, V. F. M. 1962. Snakes of southern Africa. Purnell and Sons, Cape Town. 423 pp + Pl. I-LXXIV.

FOWLIE, J. A. 1965. The snakes of Arizona: their derivation, speciation, distribution, description, and habits— a study in evolutionary herpeto-zoogeographic phylogenetic ecology. Azul Quinta Press, Fallbrook. lv + 164 pp.

FRANZEN, M. & V. WALLACH. 2002. A new *Rhinotyphlops* from southeastern Turkey (Serpentes: Typhlopidae). *J. Herpetol.* 36: 176-184.

GARMAN, S. 1884. The reptiles and batrachians of North America. *Mem. Mus. Comp. Zool.* (1883), 8(3): xxvii + 185 pp + Pl. I-IX.

GREER, A. E. 1997. The biology and evolution of Australian snakes. Surrey Beatty & Sons, Chipping Norton. xii + 358 pp.

GÜNTHER, A. C. L. G. 1864. The reptiles of British India. Ray Society, London. xxvii + 452 pp + Pl. I-XXV.

HAAS, G. 1964. Anatomical observations on the head of *Liotyphlops albirostris* (Typhlopidae, Ophidia). *Acta Zool.* 45: 1-62.

HAAS, G. 1968. Anatomical observations on the head of *Anomalepis aspinosus* (Typhlopidae, Ophidia). *Acta Zool.* 49: 63-139.

HAHN, D. E. 1979. Reptilia: Squamata: Serpentes: Leptotyphlopidae: *Leptotyphlops.* Catalogue of American amphibians and reptiles, Ithaca, New York. pp: 230.1-230.4.

________. 1980a. Liste der rezenten Amphibien und Reptilien: Anomalepididae, Leptotyphlopidae, Typhlopidae. *Das Tierreich* 101: xii + 1-93.

________. 1980b. Reptilia: Squamata: Serpentes: Leptotyphlopidae: *Leptotyphlops maximus.* Catalogue of American amphibians and reptiles, Ithaca, New York. pp: 244.1.

HOOGMOED, M. S. 1977. On a new species of *Leptotyphlops* from Surinam, with notes on the other Surinam species of the genus (Leptotyphlopidae, Serpentes).– Notes on the herpetofauna of Surinam V. *Zool. Meded.* 51: 99-123.

JAN, G. 1864. Iconographie générale des ophidiens. Première famille. Les typhlopiens. Georges Jan, Milan. 42 pp.

KINGHORN, J. R. 1948. A new species of *Typhlops* from New Britain. *Rec. Australian Mus.* 22: 67-69.

KLAUBER, L. M. 1940. The worm snakes of the genus *Leptotyphlops* in the United States and

northern Mexico. *Trans. San Diego Soc. nat. Hist.* 9: 87-162.

KOFRON, C. P. 1988. The Central and South American blindsnakes of the genus *Anomalepis. Amphibia-Reptilia* 9: 7-14.

LAURENT, R. F. 1956. Contribution à l'herpétologie de la région des Grands Lacs de l'Afrique centrale. I. Généralités - II. Chéloniens - III. Ophidiens. *Ann. Mus. Roy. Congo Belge (Sci. Zool.)* 48: 1-390 + Pl. I-XXXI.

________. 1964. A revision of the *punctatus* group of African *Typhlops* (Reptilia: Serpentes). *Bull. Mus. Comp. Zool.* 130: 387-444.

________. 1968. On some *Typhlops* from south-eastern Africa. *Arnoldia* 3: 1-2.

LE BERRE, M. 1989. Faune du Sahara. 1. Poissons-amphibiens-reptiles. Raymond Chabaud et Lechevalier, Paris. 332 pp.

LEESON, F. 1950. Identification of snakes of the Gold Coast. Crown Agents for the Colonies, London. x + 142 pp.

LEVITON, A. E., R. H. GIBBS, Jr., E. HEAL & C. E. DAWSON. 1985. Standards in herpetology and ichthyology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia* 1985: 802-832.

LIST, J. C. 1966. Comparative osteology of the snake families Typhlopidae and Leptotyphlopidae. *Illinois Biol. Monogr.* 36: 1-112 + Pl. 1-22.

MAHENDRA, B. C. 1984. Handbook of the snakes of India, Ceylon, Burma, Bangladesh and Pakistan. *Ann. Zool.* 22B: 1-412.

McDIARMID, R. W., J. A. CAMPBELL & T. A. TOURÉ. 1999. Snake species of the world: a taxonomic and geographic reference. Volume 1. The Herpetologists' League, Washington, D.C. xi + 511 pp.

McDOWELL, S. B. 1974. A catalogue of the snakes of New Guinea and the Solomons, with special reference to those in the Bernice P. Bishop Museum, Part I. Scolecophidia. *J. Herpetol.* 8: 1-57.

________. 1987. Systematics. *In:* Snakes: ecology and evolutionary biology. pp: 3-50. R. A. Seigel, J. T. Collins, & S. S. Novak (Eds). McGraw-Hill, New York.

MEIRTRE, D. 1992. Cles de determination des serpents d'Afrique. *Ann. Mus. Roy. Afrique Cent. (Sci. Zool.)* 267: 1-152.

MURPHY, R. W. 1975. Two new blind snakes (Serpentes: Leptotyphlopidae) from baja California, Mexico with a contribution to the biogeography of peninsular and insular herpetofauna. *Proc. California Acad. Sci.,* ser. 4, 40: 93-107.

NIYOMWAN, P. 1999. Species diversity, morphology and habitat types of blind snakes (family Typhlopidae) in Thailand. Chulalongkorn University, Bangkok. x + 141 pp.

OREJAS-MIRANDA, B. R. 1964. Dos nuevos Leptotyphlopidae de Sur America. *Comun. Zool. Mus. Hist. nat. Montevideo* 103: 1-7.

________. 1967. El genero *Leptotyphlops* en la región Amazônica. *Atas Simp. Biota Amazôn. (Zool.)* 5: 421-442.

________. 1969. Tres nuevos *Leptotyphlops* (Reptilia: Serpentes). *Comun. Zool. Mus. Hist. nat. Montevideo* 124: 1-11.

________& G. R. ZUG. 1974. A new tricolor *Leptotyphlops* (Reptilia: Serpentes) from Peru. *Proc. Biol. Soc. Washington* 87: 167-173.

________, G. R. ZUG, D. Y. E. GARCIA & F. ACHAVAL. 1977. Scale organs on the head of *Leptotyphlops* (Reptilia, Serpentes): a variational study. *Proc. Biol. Soc. Washington* 90: 209-213.

O'SHEA, M. 1996. A guide to the snakes of Papua New Guinea. Independent Publ., Port Moresby. xi + 239 pp.

PARKER, H. W. 1939. Reptiles and amphibians from Bougainville, Solomon Islands. *Bull. Mus. Roy. Hist. nat. Belgique* 15: 1-5.

PÉREZ-SANTOS, C. & A. G. MORENO. 1988. Ofidios de Colombia. Museo Regionale di Scienze Naturali, Torino. 517 pp + Pl. 1-38.

________. 1991. Serpientes de Ecuador. Museo Regionale di Scienze Naturali, Torino. 538 pp + Pl. 1-150.

PETERS, J. L. 1948. A new snake of the genus *Typhlops* from the Solomon Islands. *Occ. Pap. Mus. Zool. Univ. Michigan* 508: 1-3.

PETERS, W. C. H. 1865. Einen ferneren Nachtrag zu seiner Abhandlung über Typhlopina. *Mber. Königl. Akad. Wiss. Berlin* 1865: 259-263.

________. 1881. Einige herpetologische Mittheilungen. 1. Uebersicht der zu den Familien der Typhlopes und Stenostomi gehörigen Gattungen oder Untergattungen. *S.Ber. Ges. Naturf. Fruende Berlin* 1881: 69-71.

________. 1882. Zoologie III. Amphibien. Naturwissenschaftliche Reise nach Mossambique auf Befehl seiner Majestät des Königs Friedrich Wilhelm IV. In den Jahren 1842 bis 1848 ausgeführt von Wilhelm C. H. Peters. G. Reimer, Berlin. xv + 191 pp + Pl. I-XIX.

POUGH, F. H., R. M. ANDREWS, J. E. CADLE, M. L. CRUMP, A. H. SAVITZKY & K. D. WELLS. 1998. Herpetology. Prentice Hall, Upper Saddle River. xi + 577 pp.

ROMAN, B. 1980. Serpents de Haute-Volta. Centre National de la Recherche Scientifique et Technologique, Ouagadougou. 129 pp.

ROUX-ESTÈVE, R. 1974. Révision systématique des Typhlopidae d'Afrique (Reptilia-Serpentes). *Mém. Mus. Nat. Hist. nat.,* nouv. sér., 87A: 1-313.

________. 1975. Recherches sur la morphologie, la biogéographie et la phylogénie des Typhlopidae d'Afrique. *Bull. Inst. Fond. Afrique. Noire* (1974) 36A: 429-508.

________. 1979. Une nouvelle espèce de *Leptotyphlops* (Serpents) du cameroun: *Leptotyphlops perreti. Rev. Suisse Zool.* 86: 463-466.

________. 1980. Une nouvelle espèce de Typhlopidae (Serpentes) du centre-est de Madagascar: *Typhlops domerguei. Bull. Mus. Nat. Hist. nat., Paris,* sér. 4, 2A: 321-323.

ROZE, J. A. 1952. Contribucion al conocimiento de los ofidios de las familias Typhlopidae y Leptotyphlopidae en Venezuela. *Mem. Soc. Cien. nat. La Salle* 12: 143-158.

________. 1966. La taxonomia y zoogeografia de los ofidios en Venezuela. Universidad Central de Venezuela, Caracas. 362 pp.

SAINT GIRONS, H. 1972. Les serpents du Cambodge. *Mém. Mus. Nat. Hist. nat.,* sér. 2, 74A: 1-170 + Pl. I-XLII.

SAMPSON, S. D., L. M. WITMER, C. A. FORSTER, D. W. KRAUSE, P. M. O'CONNOR, P. DOBSON & F. RAVOAVY. 1998. Predatory dinosaur remains from Madagascar: implications for the Cretaceous biogeography of Gondwana. *Science* 280: 1048-1051.

SAVAGE, J. M. 2002. The amphibians and reptiles of Costa Rica: a herpetofauna between two continents, between two seas. University of Chicago Press, Chicago. xx + 934 pp.

SCHMIDT, K. P. & D. D. DAVIS. 1941. Field book of snakes of the United States and Canada.G. P. Putnam's Sons, New York. xiii + 365 pp + Pl. 1-34.

SHINE, R. 1991. Australian snakes: a natural history. Cornell University Press, Ithaca. 223 pp.

SILVA, P. H. D. H. DE. 1980. Snake fauna of Sri Lanka with special reference to skull, dentition and venom in snakes. National Museums of Sri Lanka, Colombo. xi + 472 pp + Pl. I-LVII.

SMITH, M. A. 1943. The fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese sub-region. Reptilia and Amphibia. Vol. III.–Serpentes. Taylor and Francis, London. xii + 583 pp.

STEBBINS, R. C. 1954. Amphibians and reptiles of western North America. McGraw-Hill Book Company, New York. xxii + 528 pp + Pl. 1-104.

STEJNEGER, L. 1907. Herpetology of Japan and adjacent territory. *Bull. U.S. Nat. Mus.* 58: 1-577.

STOLICZKA, F. 1871. Notes on some Indian and Burmese ophidians. *J. Asiatic Soc. Bengal (nat. Hist.)* 40: 421-445 + Pl. XXV-XXVI.

TAYLOR, E. H. 1922. The snakes of the Philippine Islands. Bureau of Printing, Manila. 312 pp + Pl. 1-37.

________. 1939a. On North American snakes of the genus *Leptotyphlops. Copeia* 1939: 1-7.

________. 1939b. Two new species of the genus *Anomalepis* Jan, with a proposal of a new

family of snakes. *Proc. New England Zool. Club* 17: 87-96.

________. 1947. Comments on Ceylonese snakes of the genus *Typhlops* with descriptions of new species. *Univ. Kansas Sci. Bull.* 31: 283-298.

________. 1965. The serpents of Thailand and adjacent waters. *Univ. Kansas Sci. Bull.* 45: 609-1096.

UNDERWOOD, G. 1967. A contribution to the classification of snakes. British Museum (Natural History), London. x + 179 pp.

VANZOLINI, P. E. 1996. A new (and very old) species of *Leptotyphlops* from northeastern Brasil (Serpentes: Leptotyphlopidae). *Pap. Avul. Zool.* 39: 281-291.

VILLA, J. D. 1988. Reptilia: Squamata: Serpentes: Typhlopidae: *Typhlops costaricensis.* Catalogue of American amphibians and reptiles, Ithaca, New York. p: 435.1.

VILLIERS, A. 1950a. Contribution à l'étude de l'Aïr (mission L. Chopard et A. Villiers). Reptiles ophidiens et chéloniens. *Mém. Inst. Franç. Afrique Noire* 10: 337-344.

________. 1950b. Les serpents de l'Ouest Africain. Institut Français d'Afrique Noire, Dakar. 148 pp.

________. 1952a. A propos de *Leptotyphlops macrorhynchus* Jan. *Bull. Inst. Franç. Afrique Noire* 14A: 243-246.

________. 1952b. La collection de serpents de l'I.F.A.N. (Acquisitions 1951). *Bull. Inst. Franç. Afrique Noire* 14A: 881-898.

________. 1954. La collection de serpents de l'I.F.A.N. (Acquisitions 1953). *Bull. Inst. Franç. Afrique Noire* 16A: 1234-1247.

________. 1963a. Serpents africains des collections du Muséum de Paris. *Bull. Inst. Franç. Afrique Noire* 25A: 1367-1373.

________. 1963b. Les serpents de l'Ouest Africain. 2nd ed. Institut Français d'Afrique Noire, Dakar. 190 pp.

________. 1975. Les serpents de l'Ouest Africain. 3rd ed. Les Nouvelles Éditions Africains, Dakar. 195 pp.

WAGLER, J. G. 1830. Natürliches System der Amphibien, mit vorangehender Classification der Säugthiere und Vögel. Ein Beitrag zur vergleichenden Zoologie. J. G. Cotta'schen Buchhandlung, München. vi + 354 pp.

WAITE, E. R. 1897. A new blind snake from the Duke of York Island. *Rec. Australian Mus.* 3: 69-70.

________. 1918. Description of a new blind snake from the Solomon Islands, with a list of species from the Austro-Malayan and Polynesian sub-regions. *Rec. So. Australian Mus.* 1: 35-38.

________. 1929. The reptiles and amphibians of South Australia. Harrison Weir, Adelaide. 270 pp.

WALL, F. 1908. Notes on a collection of snakes from Persia. *J. Bombay nat. Hist. Soc.* 18: 795-805.

________. 1918. A popular treatise on the common Indian snakes. Part. XXIV. Family—Typhlopidae. *J. Bombay nat. Hist. Soc.* 25: 375-382.

________. 1921. Ophidia Taprobanica or the snakes of Ceylon. H. R. Cottle, Colombo. xxii + 581 pp.

WALLACH, V. 1985. A cladistic analysis of the terrestrial Australian Elapidae. *In:* Biology of Australasian frogs and lizards. pp: 223-253. G. Grigg, R. Shine, & H. Ehmann (Eds). Royal Zoological Society of New South Wales, Chipping Norton.

________. 1993a. The supralabial imbrication pattern of the Typhlopoidea. *J. Herpetol.* 27: 214-218.

________. 1993b. A new species of blind snake, *Typhlops marxi,* from the Philippines (Serpentes: Typhlopidae). *Raffles Bull. Zool.* 41: 263-278.

________. 1994. The status of the Indian endemic *Typhlops acutus* (Duméril & Bibron) and the identity of *Typhlops psittacus* Werner (Reptilia, Serpentes, Typhlopidae). *Bull. Inst. Roy. Sci. Nat. Belgique* 64: 209-229.

________. 1995. A new genus for the *Ramphotyphlops subocularis* species group (Serpentes: Typhlopidae), with description of a new species. *Asiatic Herpetol. Res.* 6: 132-150.

________. 1996. Two new blind snakes of the *Typhlops ater* species group from Papua New Guinea (Serpentes: Typhlopidae). *Russian J. Herpetol.* 3: 107-118.

________. 1997. *Leptotyphlops broadleyi,* a new species of worm snake from Côte d'Ivoire (Serpentes: Leptotyphlopidae). *African J. Herpetol.* 46: 103-109.

________. 1998. The visceral anatomy of blindsnakes and wormsnakes and its systematic implications (Serpentes: Anomalepididae, Typhlopidae, Leptotyphlopidae). Unpubl. Ph.D. Dissertation, Northeastern Univ., Boston. xxv + 611 pp.

________. 2001. *Typhlops roxaneae,* a new species of Thai blindsnake from the *T. diardii* species group, with a synopsis of the Typhlopidae of Thailand (Serpentes: Scolecophidia). *Raffles Bull. Zool.* 49: 39-49.

________. 2003. *Typhlops etheridgei,* a new species of african blindsnake in the *Typhlops vermicularis* species group from Mauritania (Serpentes: Typhlopidae). *Hamadryad* 27: 108-122.

________& R. GÜNTHER. 1997. Typhlopidae vs. Anomalepididae: the identity of *Typhlops mutilatus* Werner (Reptilia: Serpentes). *Mitt. Zool. Mus. Berlin* 73: 333-342.

________& I. INEICH. 1996. Redescription of a rare Malagasy blind snake, *Typhlops grandidieri* Mocquard, with placement in a new genus (Serpentes: Typhlopidae). *J. Herpetol.* 30: 367-376.

WORRELL, E. 1963. Reptiles of Australia: crocodiles- turtles- tortoises- lizards- snakes. Angus and Robertson, Sydney. xv + 169 pp + Pl. 1-64.

WYNN, A. H. & A. E. LEVITON. 1993. Two new species of blind snake, genus *Typhlops* (Reptilia: Squamata: Typhlopidae), from the Philippine Archipelago. *Proc. Biol. Soc. Washington* 106: 34-45.

APPENDIX I

MATERIAL EXAMINED

Anomalepis aspinosus. PERU, MCZ 14782 (holotype). *A. colombia.* COLOMBIA, FMNH 54986 (holotype). *A. flavapices.* ECUADOR, USNM 196349 (holotype). *A. mexicanus.* PANAMA, NEUCVS 944; PERU, LSUMZ 19450-51, 19453, 32591. *Helminthophis flavoterminatus.* VENEZUELA, BMNH 1886.7.27.7, ZMB 6708; SOUTH AMERICA, MCZ 5129-30. *H. frontalis.* COSTA RICA, MCZ 55117, 34879. *H. praeocularis.* COLOMBIA, FMNH 30814, MCZ 17960, 19196. *Liotyphlops albirostris.* COLOMBIA, MCZ 29324; PANAMA, FMNH 216257, KU 116887-88, 116891, 165197, SDSNH 34608, 35833, 35500-01, 36260, 36451, 36660, 38032, 40331, USNM 306188; VENEZUELA, CAS 94620. *L. anops.* COLOMBIA, MCZ 67936-37, 150203. *L. argaleus.* COLOMBIA, MCZ 66383. *L. beui.* BRAZIL, MCZ 16702, 17842, 142557, 142576. *L. ternetzii.* BRAZIL, LSUMZ 46268. *L. wilderi.* BRAZIL, FMNH 73387 (syntype), ZMUC 52182. *Typhlophis squamosus.* BRAZIL, MCZ 145403, NHRM 31375; GUYANA, KU 69819; SOUTH AMERICA, ZMB 48044.

Acutotyphlops: (see Wallach, 1995, for material examined). *Cyclotyphlops deharvengi:* INDONESIA, MNHN 1990.4279 (holotype). *Grypotyphlops acutus.* INDIA, CAS 17170, CAS-SU 12514-17, 13666, FMNH 8651, IRSNB 2017 (holotype of *T. psittacus),* MCZ 3849, 18033, UF 19900-01, 19902 (neotype), USNM 122276, 122278. *Ramphotyphlops affinis.* AUSTRALIA, FMNH 97878, 97880, MCZ 35020, QM 11631, 46706. *R. albiceps.* HONG KONG, BMNH 1954.1.13.4, 1983.946, SLS 196; THAILAND, BMNH 1946.1.10.50 (holotype), MCZ 181196, ZMUC 52203-04, ZRC 3043-45. *R. braminus.* COMOROS, CAS 16937, ZFMK 32119-21; HONG KONG, MCZ 172796, 175924; MADAGASCAR, BYU 42282-84, FMNH 18283, MCZ 181301, UMMZ 209690-93, 209695, 209697-98, ZFMK 9161, 19299-302, 60790, 70001, ZSM 1219/0; MASCARENES, ZFMK 35704-05; MAURITIUS, USNM 150957; PHILIPPINES, FMNH 53251; SEYCHELLES, UMMZ 167976-77; THAILAND, NHCL 5039-40. *R. cumingii.* PHILIPPINES, CAS 169878, CAS-SU 25483, FMNH 41092, 53221, MCZ 25590-92. *R. depressus.* PAPUA NEW GUINEA, MCZ 90994, 90998, 92508, 153106-07, 140722, ZMB 9667 (holotype), 14643. *R. erycinus.* INDONESIA, MCZ 49619, 49396, 140754. *R. exocoeti.* CHRISTMAS ISLAND, AMS 93689, CAS 16867, MCZ 28643. *R. flaviventer.* INDONESIA, BPBM 3127, FMNH 42352, 73846, MCZ 7571, 171562-63, USNM 216003, ZMB 5029 (holotype). *R. mansuetus.* PAPUA NEW GUINEA, MCZ 92527; SOLOMONS, MCZ 14270 (holotype). *R. multilineatus.* NEW GUINEA, ZMA 17765. *R. olivaceus.* PHILIPPINES, CAS 169878, CAS-SU 25483, FMNH 41092, 53221, MCZ 25590-92. *R. ozakiae.* THAILAND, FMNH 180003-06, 180007 (holotype), ZMUC 52174. *R. polygrammicus.* AUSTRALIA, FMNH 97892, MCZ 128633; INDONESIA, FMNH 154852, MCZ 252289; PAPUA NEW GUINEA, MCZ 74161-62, 129888, 135356, 135500, 135506. *Rhinotyphlops anomalus.* ANGOLA, MCZ 25870. *R. boylei.* BOTSWANA, NMZB 15184. *R. crossii.* NIGERIA, BYU 18075, 92730, CM 92682-83, FMNH 25055, MCZ 49012. *R. debilis.* CENTRAL AFRICAN REPUBLIC, MNHN 1991.377-78, 1997.3195-96, 1998.268. *R. episcopus.* TURKEY, ZFMK 74225-26, ZSM 949-50/2000. *R. erythraeus.* ETHIOPIA, NMW 16949. *R. feae.* SÃO TOMÉ, CAS 218907, 219310, 219335, 219337, ZMUC 257. *R. gracilis.* ZAMBIA, CM 90396-97, IRSNB 15391, MCZ 54051-52, 54054. *R. graueri.* DEMOCRATIC REPUBLIC OF CONGO, ZMB 27161; TANZANIA, MCZ 30034, 48052-54, 54812, ZFMK 63138. *R. katangensis.* DEMOCRATIC REPUBLIC OF CONGO., MCZ 42896. *R. kibarae.* DEMOCRATIC REPUBLIC OF CONGO, IRSNB

2198-99, 2200, 2202, 8059, MCZ 54379. *R. lalandei.* SOUTH AFRICA, CAS 160747, MCZ 29418, 43020, PEM 8227. *R. lumbriciformis.* KENYA, USNM 43097; TANZANIA, MCZ 48045, 48047; ZANZIBAR, MCZ 46115. *R. mucruso.* KENYA, USNM 20125 (holotype of *T. mandensis),* 20213-14; TANZANIA, CAS 225083, MCZ 52549, 52559, 52621; ZIMBABWE, MCZ 44457. *R. newtoni.* SÃO TOMÉ, CAS 218908, UMMZ 187932. *R. praeocularis.* DEMOCRATIC REPUBLIC OF CONGO, USNM 167001; NIGERIA, ZMUC 52197; WEST AFRICA, FMNH 75088. *R. rufescens.* CENTRAL AFRICAN REPUBLIC, MNHN 1991.379, 1995.9606, 1997.3194, 1997.3197. *R. schinzi.* NAMIBIA, FMNH 187111, 233343, TM 48347, 48928. *R. schlegelii.* BOTSWANA, NMZB-UM 18090, 24164; MOZAMBIQUE, FMNH 190714, 200283; SOUTH AFRICA, FMNH 224413, TM 4903, 13832, 13950, 80530, 50551. *R. simoni.* ISRAEL, FMNH 69219, TAU 163, 1250-51, 2127, 8218, USNM 336231; SYRIA, MCZ 22083. *R. stejnegeri.* DEMOCRATIC REPUBLIC OF CONGO, BMNH 1980.32, USNM 23979. *R. sudanensis.* DEMOCRATIC REPUBLIC OF CONGO, AMNH 11677-78, 11680, 11682, IRSNB 11515-18, 11520, MCZ 13599. *R. uluguruensis.* TANZANIA, MCZ 23081. *R. wittei.* CONGO, IRSNB 2511 (holotype), 2512. *Typhlops ater.* INDONESIA, FMNH 142108, MCZ 33505, NMBA 979, ZMA 17737. *T. bothriorhynchus.* MYANMAR, UF 48813. *T. castanotus.* PHILIPPINES, CAS 127973, CAS-SU 27942, MCZ 25594.*T. collaris.* PHILIPPINES, UF 54186, 68443. *T. comorensis.* COMOROS, BMNH 1946.1.11.92 (holotype), MNHN 1889.23-26, 1895.126, 1902.391. *T. conradi.* INDONESIA, ZMB 7934 (holotype). *T. depressiceps.* PAPUA NEW GUINEA, MCZ 145954, USNM 195953, ZMB 23986. *T. diardii.* INDIA, CAS-SU 13982, MCZ 165004; THAILAND, FMNH 180008, 180023; VIETNAM, FMNH 252064, ROM 25640. *T. fredparkeri.* PAPUA NEW GUINEA, MCZ 142651 (holotype). *T. hedraeus.* PHILIPPINES, MCZ 17578, USNM 229285, 498958. *T. inornatus.* PAPUA NEW GUINEA, MCZ 140724, 140728, 175100, UPNG 8572. *T. khoratensis.* THAILAND, CAS 13667, FMNH 189933, MCZ 74097, NHCL 5041. *T. klemmeri.* MALAYSIA, FMNH 178238 (holotype). *T. koekkoeki.* MALAYSIA, FMNH 71579. *T. kraali.* INDONESIA, ZMA 14225. *T. mcdowelli.* PAPUA NEW GUINEA, PNGM 24604, UPNG 5978, 7502 (holotype). *T. muelleri.* MALAYSIA, FMNH 161275; MYANMAR, CAS 222410; THAILAND, IRSNB 16535, NHCL 5038, TNRC 3788, 7336-37; VIETNAM, BPBM 2156, FMNH 252063, USNM 86885. *T. roxaneae.* THAILAND, MCZ 177984 (holotype). *T. ruber.* PHILIPPINES, CAS 182566, FMNH 53223, MCZ 79698. *T. ruficaudus.* PHILIPPINES, CAS 135667, CAS-SU 19517, 21066, 26815, UF 54652. *T. schmidti laurenti.* ZAMBIA, NMZB-UM 9445. *T. schmutzi.* INDONESIA, UF 29452, 29528, 37018. *T. siamensis.* THAILAND, MCZ 16655, TCWC 29356 *T. trangensis.* THAILAND, FMNH 178236 (holotype).

Leptotyphlops albifrons. PERU, FMNH 40626, MCZ 17393; VENEZUELA, ZSM 107/1990. *L. algeriensis.* MALI, CAS 84215. *L. bicolor.* GHANA, CAS 103292, 136146, 146008-09, FMNH 42565, MCZ 53655, 55382, NMZB 12304. *L. boueti.* BURKINA FASO, MHNG 1579.16; MALI, MNHN 1917.24 (holotype); SÉNÉGAL, MCZ 53273, MNHN 1983.474, USNM 161991-92. *L. braccianii.* ERITREA, MSNM 3348, 3351 (holotype), 3352; KENYA, MCZ 40089; SOMALIA, MZUF 2585, 15628; SUDAN, MCZ 52190, 53330-31. *L. broadleyi.* IVORY COAST, MHNG 1469.2, MNHN 1977.92-103. *L. cairi.* EGYPT, CAS 18144-45, 18148, FMNH 64030, 64038, 129894, NMZB 15419, USNM 130459; SOMALIA, MZUF 27192; SUDAN, BMNH 1897.10.28.537, NMW 15456, 15458, 17004. *L. erythraeus.* ERITREA, MSNM 3349 (holotype), MZUF 12270, 30109. *L. hamulirostris.* IRAN, CAS 99737 (lectotype), NMW 17131-35. *L. macrorhynchus.* GAMBIA, NHRM 5490 (holotype of *L. natatrix);* KENYA, BMNH 1932.5.2.95, MHNG 1561.87, MVZ 200827; SOMALIA, MCZ 74163, NHCL 1542, 1801; TANZANIA, CAS 89734; TURKEY, CAS 105400, 105928. *L. phillipsi.* ISRAEL, MCZ 51662, SMF 47115-16; JORDAN, FMNH 73385, HUJ 8122, MCZ 9639-44, 9646, 9650 (holotype), UMMZ 51761. *L. sundewalli.* CENTRAL AFRICAN REPUBLIC, MNHN 1997.3189, 1997.3191, ZFMK 33688; GHANA, FMNH 196258, MCZ 55396. *L. tenellus.* TRINIDAD, CAS-SU 12510, FMNH 217237-38, MCZ 160088. *Rhinoleptus koniagui.* GUINÉE-BISSAU, MNHN 1902.10.

Received: 3 March 2003.
Accepted: 28 June 2003.

Hamadryad Vol. 27, No. 2, pp. 241 – 247, 2003.

BASKING BEHAVIOUR AND SURVEY OF MARSH CROCODILES, *CROCODYLUS PALUSTRIS* (LESSON, 1831) IN RANGANTHITTU BIRD SANCTUARY, KARNATAKA, INDIA

P. Dilip Venugopal[1, 2] and K. V. Devi Prasad

Sálim Ali School of Ecology, Pondicherry University, Pondicherry 605 014, India.
[1]Wildlife Conservation Society– India Program, 403, Seebo Apartments, 26-2, Aga Abbas Ali Road, Bangalore 560 042, India.
[2]Present address: FERAL, P. B. 28, Pondicherry 605 001, India.
Email:dilipvenugopal@yahoo.com

(with three text-figures)

ABSTRACT.– The basking behaviour of a wild population of marsh crocodiles or mugger, *Crocodylus palustris* was studied. The basking pattern had a bimodal form in the early part of the study but changed towards the later. The number of observations of crocodiles basking on land reduced as the study progressed and contact with water, increased towards the end of the study. Land basking was influenced by water temperature. A total of 64.52% of observations of basking juveniles were between 0700-0959 h, while adults and subadults started to bask later. The crocodile population in the study site was not less than 29 individuals, comprising 17 adults and 11 subadults. Crocodiles in the regular tourist boat zone appear to have become accustomed to the presence of boats and humans.

KEYWORDS.– *Crocodylus palustris,* basking behaviour, boat counts, wariness, Ranganthittu Bird Sanctuary, India.

INTRODUCTION

Temperature regulation is a dynamic process that involves behavioural and physiological adjustments in order to maintain body temperature within a range. The rise in body temperature of reptiles is achieved through external heat sources (Pough, 1983) and is accomplished in part by a combination of heliothermy (basking in the sun) and thigmothermy (absorbing heat from a warm surface) (Huey, 1982). The ability to regulate body temperature on a daily and/or seasonal basis with comparatively minor energetic costs, are the advantages of ectothermy (Lang, 1987b). Fluctuating environmental conditions that differ from thermal preferences of reptiles increase the time required to thermoregulate. The consequences of devoting time to thermoregulation have broad behavioural and ecological significance. The time spent in thermoregulation can sometimes reduce the time available for other important activities (Huey, 1982). Climatic conditions, social interactions, circadian rhythms and reproductive state influence thermal behaviour (Lang, 1987b).

The land–water movement of crocodiles is triggered by a light-cued circadian rhythm and the amphibious life of crocodiles has been suggested to serve as a thermoregulatory function (Lang, 1976; 1987b). Radio-telemetric studies (Spotila, 1974; Smith, 1975; Lang, 1975; Loveridge, 1984) confirm that specific heat seeking and heat avoiding behaviour on land and in water facilitate crocodiles in regulating their body temperature.

Studies on crocodilian thermoregulation have been conducted on *Crocodylus niloticus* by Modha (1968); *C. porosus* and *C. johnsoni* by Johnson (1973); *Alligator mississippiensis* by Lang (1975) and Smith (1975); *Gavialis gangeticus* by Singh and Bustard (1977) and *C. acutus* by Lang (1979). However, thermoregulatory studies on *Crocodylus palustris* in the wild have been few (Gupta and Sri Hari, 1989 for example). Lang (1987b),

Whitaker and Whitaker (1989) and Tibbo (1991) have studied the thermoregulatory behaviour of captive populations of *Crocodylus palustris*. We aimed at studying the basking behaviour of a wild population of *Crocodylus palustris*, the marsh crocodile or mugger, and made an attempt at understanding the effects of environmental parameters on the basking behaviour. The survey conducted by Whitaker and Daniels (1980) in Ranganthittu is the only population estimate available and there is no information on the status of muggers for the state of Karnataka.

STUDY SITE

Ranganthittu Bird Sanctuary (12^o 24'N; 76^o 40'E) is located 19 km from Mysore city, and has an area of 0.67 sq. km. The sanctuary is a cluster of two unconnected islets that are surrounded by water from a reservoir formed by the construction of a check dam along the Cauvery River. Altitude ranges from 690 to 715 m and mean annual rainfall is 800 mm. Ranganthittu has a moderate climate with 36^{o}C and 14^{o}C as the maximum and minimum temperatures, respectively (Manjrekar, 2000).

The sanctuary consists of riverine and deciduous forests. This riverine ecosystem of rocky outcrops and islets, contain suitable basking sites for the crocodiles. The isolation of the islets during monsoons and the abundance of aquatic insects and fishes make the place a refuge for birds. The sanctuary attracts a large number of tourists, especially during summer when migratory birds nest. The study was conducted between December 2000 to April 2001 in the western portion of the Sanctuary.

METHODOLOGY

Basking behaviour.- A reconnaissance of the area was conducted prior to the study, to establish the preferred basking sites in the sanctuary. A transect (1.1 km in length) along the river bank, from which most of the preferred basking sites were visible, was walked within the first 25 min of every hour from 0700 to 1800 h. The total number of observations of crocodiles basking at each hour interval was recorded. Basking behaviour was classified as:

Surface bask, when the crocodile observed was on the surface of the water without any movement.

Prebask, when half to two-thirds of the body was still in water and,

Basking, when the crocodile was completely out on land, exposing the entire body.

The basking substrates in prebask and basking phases was recorded as bare soil, soil with vegetation or rock. The presence of crocodiles in the sun or in shade was also recorded. The sizes of the crocodiles basking were estimated visually and then grouped under three broad categories: below 1m, 1 to 1.5 m and > 1.5 m.

Temperatures of air in the shade and open, water, and relative humidity were recorded every alternate hour. Thermister probes (YSI 400 series) calibrated to an NBS-traceable certified thermometer, were placed in shade, sun and in water. A digital thermometer (Tegam V 500, with an accuracy ± 0.1ºC) and a hygrometer (Fischer's Hair Hygrometer) were used. Data were collected from mid-January to April 2001 for a period of six weeks (total of 385 man-hours). The crocodiles were observed using a field binocular (8 x 32).

Status survey and wariness in crocodiles.- The sanctuary was surveyed for crocodiles from a row boat (of dimensions ca. 4 x 2.2 m), six times, between 1600 and 1745 h on five days and between 1200-1345 h on one day. The boat speed and the route were maintained uniform to avoid sampling errors. The crocodiles sighted, were classified as hatchlings and juveniles (below 1 m), subadults (1-1.5 m) and adults (above 1.5 m). Individuals that were unclassified were placed under a separate category 'unknown' to be included in the counts.

Wariness, as previously described by Webb and Messel (1979), was defined as the distance to which an animal could be approached, before it attempted to escape. Based on the frequency of tourist boat trips, the entire study area was categorized into regular boating zone, RBZ; limited boating zone, LBZ and no boating zone, NBZ. The basking crocodiles were approached and their flight distance was estimated visually in meters, in the three zones.

RESULTS

Daily basking activity pattern.- A total of 3,630 observations of basking crocodiles were made during the entire sampling period of 385 hours. Bimodal basking activity pattern with pre-midday and post-midday basking peaks was evident between January - February (Fig. 1). The crocodiles started arriving for basking by 0800 h and by 1100 h, pre-midday basking peak was reached. The number of observations of basking crocodiles reduced after that, only to increase again from 1400 h and peak at 1700 h. However, by the end of March, there was no clear pattern in daily basking behaviour. After the pre-midday basking peak, the number of observations of basking crocodiles was reduced. Additionally, the crocodiles were observed to arrive earlier (0700 h) for basking. The number of observations of basking crocodiles reduced gradually as the weeks progressed.

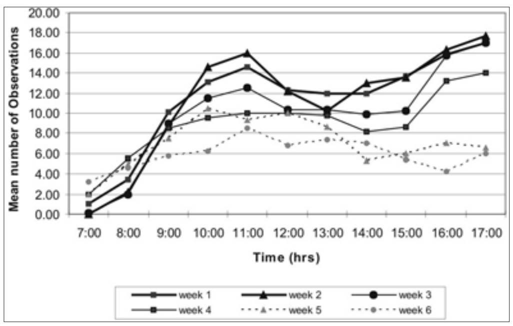

FIGURE 1: The mean number of observations of *Crocodylus palustris* basking at each hour during six weeks of the study.

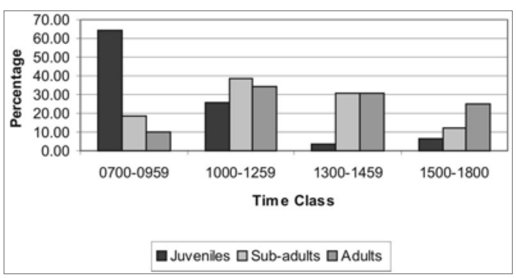

FIGURE 2: Proportion of *Crocodylus palustris* of different sizes observed basking at different time intervals.

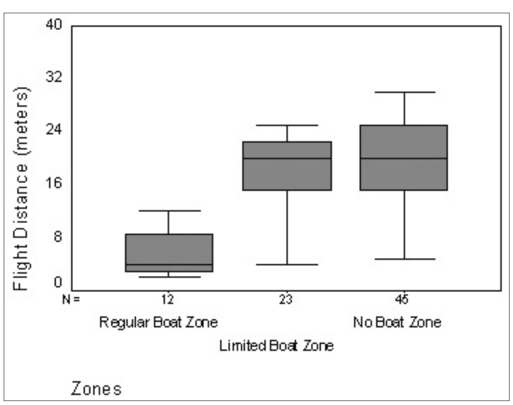

FIGURE 3: Mean flight distance of *Crocodylus palustris* in the different zones of the study site.

Choice of basking phase, substrate and shade/sun.- The number of crocodiles in the 'basking' phase was higher than those in the other phases, during January - February. However, by the end of March, those in 'surface bask' category were higher and only at 1700 h were the number of crocodiles more in the basking phase. Thus there was a change in the choice of basking phase, from land basking to basking in contact with water. No specific pattern in the levels of exposure of body while basking was observed.

Rocks were observed to be the most preferred basking substrate, with 67.02% of observations of basking crocodiles on rocks (n = 1,794). However, the number of observations of crocodiles basking on soil banks, increased gradually through the day. The crocodiles were observed to move from rocks to the bare soil during the afternoons. Observations of crocodiles basking on soil with vegetation (n = 36) were few. The crocodiles were observed to shift from one location to another based on the availability of shade and sun during the afternoon.

The mean ambient air temperature and mean water temperature during January-February was 25.2°C (range = 15–31.6°C) and 25.3°C (range = 22–28°C), respectively. During the end of March, mean ambient air temperature and mean water temperature increased to 28.4°C (range = 19.9–33.6°C) and 28.7°C (range 27–29.9°C), respectively. The correlation between the total number of observations of crocodiles basking in different phases and the environmental parameters was calculated using Spearman's correlation. For the entire study period, water temperature was significantly correlated nega-

tively (r = -0.510, p = 0.000; N = 213) to the total number of observations of crocodiles basking out on land. Land basking was influenced by water temperature. The temperature of air and relative atmospheric humidity did not show any significant relationship.

Basking behaviour of different size/age muggers.- The juveniles were observed to bask earlier in the day (Fig. 2). 64.52% (number of observations = 20) of the sightings of juveniles basking were between 0700-0959 h. The proportion of subadults and adults observed basking increased at 1000–1259 h and reduced between 1300–1459 h. The proportion of adults was higher than that of subadults, between 1500–1759 h. Basking hatchings or yearlings were not sighted.

Status survey.- In all, 29 individuals were sighted during one of the boat counts (Table 1). The maximum number of adults, subadults and juveniles sighted were 17, 11 and 1, respectively. Hatchlings/yearlings were not sighted during the boat counts, but an yearling was captured in the agricultural field nearby.

Wariness in crocodiles.- The mean flight distance of crocodiles was higher (Fig. 3) in the NBZ (mean = 22.91, SD = 13.35, SE = 1. 84, Number of observations = 45) and LBZ (mean = 19.87, SD = 8.98, SE = 1.98, number of observations = 23) compared that of the RBZ (mean = 5.67, SD = 3.77, SE = 1.09, number of observations = 12). The number of crocodiles observed in the NBZ was higher than that of LBZ followed by RBZ. The results suggest that tourism could have an impact on crocodile response to human presence.

DISCUSSION

Daily basking activity pattern.- The bimodal basking pattern with two-peak basking sessions in a day has been described for *Crocodylus palustris* (Tibbo, 1991), *Alligator mississippiensis* (Lang, 1987b), *C. niloticus* (Modha, 1968; Loveridge, 1984) and *Gavialis gangeticus* (Kumar, 1988). However, during our study, the daily basking pattern varied and the bimodal activity pattern observed during January - February changed during the later weeks of March. Whitaker and Whitaker (1989) reported that during the hot season, diurnal basking by muggers in the Madras Crocodile Bank Trust was significantly less and they spent most of the time submerged. Gupta and Sri Hari (1989), at Bhorsainda Crocodile Sanctuary, recognized basking behaviour in *Crocodylus palustris* as varying throughout the year. Similarly, the daytime basking in gharials was found to be declining from January – March (Kumar, 1988). Lang (1987b) reported that during the 'warmer months', *Crocodylus novaeguineae* and *C. porosus* in Papua New Guinea, *Caiman crocodylus* in Venezuela, *Gavialis gangeticus, C. porosus* and *C. palustris* in southern India all moved on to land at night and cooled below ambient water temperature by early morning. While our data confirm some of the observations above, our observations also suggest that the changes in basking behaviour, in respect of time spent and

TABLE 1: Enumeration and classification of *Crocodylus palustris* recorded during boat counts.

Date	Hatchlings	Subadults	Adults	Unknown	Total
10.1.2001	0	6	13	7	26
09.02.2001	0	6	15	2	23
16.02.2001	0	11	17	1	29
05.03.2001	1	5	12	1	19
12.03.2001	1	8	7	0	16
16.03.2001	1	5	11	0	17
Mean	0.5	6.83	12.5	1.83	21.66
Std. Deviation	0.548	2.317	3.450	2.639	5.203
Std. Error	0.224	0.946	1.408	1.078	2.124

time of day, are season-dependent. But any definitive conclusion can be arrived at only after a detailed study on the heat-transfer characteristics of the substrates as well as the internal temperature of the animals. Such measurements were beyond the scope of the present study.

Choice of basking phase, substrate and sun/shade.- Smith (1975) reported that *Alligator mississippiensis* does not to emerge directly from deep water to the land, but prebask in the shoreline. Seebacher (1999) categorized posturing as the proportion of surface area exposed from water and reported that *Crocodylus johnsoni* showed an array of intermediate postures. No such clear pattern for the levels of exposure of body was observed during our study. Muggers were observed to emerge out of water directly on to land without intermediate phases and were also observed in different intermediate levels of body exposure.

Rocks were the most preferred basking substrate. There were few sightings of crocodiles basking on the soil with vegetation (n = 36). The reason for avoidance of vegetated site could not be ascertained but such basking sites were uncommon in the study area. Seebacher and Grigg (1997) also observed that rocks were the most preferred basking sites for *Crocodylus johnsoni*. Data on substrate temperature were not collected.

Tibbo (1991) found that thermoregulation in captive *Crocodylus palustris* at the Madras Crocodile Bank, involved selection of different positions within the enclosure according to the extent of solar radiation and reported that basking increased significantly on clear sunny days. Our observations also confirm the report by Tibbo (1991) that the crocodiles shifted from one location to another based on the availability of shade and sun during the afternoons. Further, the synergistic combinations of the basking phase, substrate and whether in sun or shade, might enhance the thermoregulatory performance of the muggers based on their selection of these parameters.

Smith (1975) reported that land basking in crocodiles might occur when the air temperature exceeded the water temperature. Gupta and Sri Hari (1989) reported that low air temperatures inhibited basking in muggers. In *Gavialis gangeticus*, land basking was mainly influenced by atmospheric and soil temperatures (Kumar, 1988). Social context, nutritional status, infection and the incubation temperature alter the selected body temperature (Tb) of the crocodiles (Lang, 1987b). The preferred Tb of the crocodilians ranges between 25-35ºC (Lang, 1987a) and the preferred Tb of *C. palustris* is 28-31ºC (Harry Andrews, personal communication). There were more crocodiles basking on land during January - February when the mean water temperature (see results) was lower than that of the preferred Tb. However, as the study progressed, the water temperature increased closer to the preferred Tb. This resulted in the gradual decrease in the number of crocodiles basking out on land and an increased contact with water. The thermal behaviour and body temperatures of crocodiles are strongly influenced by ambient water temperature and its seasonal changes (Lang, 1987a). The preferred body temperature of thermoregulating *C. johnsoni* increased seasonally (winter – summer), 29-33° C, being parallel to that of the increase in the water temperature (Seebacher and Grigg, 1997). Although our observations elucidate the effect of water temperature on the thermal behaviour of *Crocodylus palustris*, the mode of temperature control in muggers could not be established due to lack of data on body temperature. However, observations on the behavioural adjustments that augment thermoregulation have been presented here.

Basking behaviour of different size/age muggers.- Social interactions interfere with thermoregulation (Huey, 1982) and the basking sites are physically competed for (Magnuson et al., 1979). The crocodiles were frequently observed to snap at each other and the smaller individuals were chased away by the larger ones. The early arrival of juveniles to bask could be to avoid interactions with the dominant larger individuals, which were observed to arrive later for basking. However, Seebacher and Grigg (1997) report that the dominant individuals frequently preventing the subordinates from increasing

their Tb to the preferred range could have an effect on the fitness of the subordinates. The presence of basking adults in all the time classes suggests that the larger individuals require basking for a longer duration. But this could not be established because the crocodiles were not identified individually.

Status survey and wariness in crocodiles.- Whitaker and Daniels (1980), in their countrywide status survey of crocodilians reported that there were less than 10 adults in Ranganthittu. During this study, 17 adults were sighted in one of the boat counts, suggesting an increase in the population of muggers in Ranganthittu. Hatchlings and yearlings are known to be wary and this could be the reason for not sighting them during the boat surveys.

The crocodiles in the RBZ were less wary and they could be approached close. This suggests that the crocodiles in the RBZ have become accustomed to the presence of humans and boats. The presence of more number of individuals in the NBZ than in the other zones suggests that the crocodiles preferred basking sites that were less disturbed. But the wariness of crocodiles towards boats and humans in general, is higher in the NBZ and the LBZ. Webb and Messel (1979) reported that wariness increased with increasing hunting and disturbance. The illegal fishing and dynamiting in the NBZ and the LBZ could be the reason for the wariness of crocodiles in these zones.

ACKNOWLEDGEMENTS

The Wildlife Conservation Society-India funded the study and The Madras Crocodile Bank Trust provided the equipment. The Karnataka Forest Department granted the permission to conduct the study. PDV thanks Renee Borges and the staff of the Center for Ecological Studies, Indian Institute of Sciences for the facilities provided. We thank N. V. Joshi, Perran Ross, Harry Andrews and N. M. Ishwar for useful suggestions and comments and Muruga for his assistance in fieldwork.

LITERATURE CITED

GUPTA, R. C. & P. SRI HARI. 1989. On the basking behaviour of the mugger *Crocodylus palustris* at Bhorsainda Crocodile Sanctuary, Haryana, India. *J. Bombay. nat. History. Soc*. 86(2): 170-174.

HUEY, R. B. 1982. Temperature, physiology, and the ecology of reptiles. *In*: Biology of the Reptilia. Vol. 12. pp: 25-67. C. Gans & F. H. Pough (Eds). Academic Press. New York.

JOHNSON, C. R. 1973. Behaviour of the Australian crocodile *C. johnstoni* and *C. porosus*. *Zool. J. Linn. Soc*. 52: 315-336.

KUMAR, R. 1988. Basking behaviour of gharials. Unpublished Masters dissertation. Bharathidasan University, Tiruchirapalli. 54 pp.

LANG, J. W. 1975. Thermoregulatory behavior of adult American alligators. *American Zool*. 15: 797.

________. 1976. Amphibious behavior of *Alligator mississippiensis*: roles of circadian rhythm and light. *Science* 191: 575-577.

________. 1979. Thermophilic response of the American alligator and the American crocodile to feeding. *Copeia* 1979: 48-59.

________. 1987a. Crocodilian behaviour and its management implications. *In*: Wildlife management: crocodiles and alligators. pp: 273-294. G. J. W. Webb, S. C. Manolis & P. J. Whitehead (Eds). Surrey Beatty and Sons Pty Limited/Conservation Commission of the Northern Territory, Chipping Norton.

________. 1987b. Crocodilian thermal selection. *In*: Wildlife management: crocodiles and alligators. pp: 301-317. G. J. W. Webb, S. C. Manolis & P. J. Whitehead (Eds). Surrey Beatty and Sons Pty Limited/Conservation Commission of the Northern Territory, Chipping Norton.

LOVERIDGE, J. P. 1984. Thermoregulation in Nile crocodiles. *In*: Structure, development and evolution of reptiles. pp: 443-468. M. W. J. Ferguson (Ed). Academic Press. London.

MAGNUSON, J. J., L. B. CROWDER & P. A. MEDVICK. 1979. Temperature as an ecological resource. *American Zool*. 19: 331-343.

MANJREKAR, N. (Ed). 2000. A walk on the wild side: an information guide to the National Parks and Wildlife Sanctuaries of Karnataka. Karnataka Forest Department (Wildlife Wing), Bangalore, 80 pp.

MODHA, M. L. 1968. Basking behaviour of the Nile crocodile on Central Island, Lake Rudolf. *E. African Wildl. J*. 8: 81-89.

POUGH, F. H. 1983. Amphibians and reptiles as low energy systems. *In*: Behavioral energetics: the costs of survival in vertebrates. pp: 141-188. W. P. Aspey & S. I. Lustick (Eds). Ohio State Univ. Biosciences Colloquia, No. 7. Ohio State Univ Press, Columbus, Ohio.

SEEBACHER, F. 1999. Behavioral postures and the rate of body temperature change in wild freshwater crocodiles, *Crocodylus johnstoni*. *Physiol. & Biochem. Zool*. 72 (1): 57-63.

________ & G. C. GRIGG. 1997. Patterns of body temperatures in wild freshwater crocodiles *Crocodylus johnstoni*: thermoregulation versus thermoconformity, seasonal acclimatization and the effect of social interactions. *Copeia* 1997(3): 549-557.

SINGH, L. A. K. & H. R. BUSTARD. 1977. Locomotory behaviour during basking and spoor formation in gharial. *British J. Herpetol*. 5: 673-676.

SMITH, E. N. 1975. Thermoregulation of the American alligator, *Alligator mississippiensis*. *Physiol. Zool*. 48(2): 177-194.

SPOTILA, J. R. 1974. Behavioral Thermoregulation of the American alligator. *In*: Thermal ecology. pp: 322-334. J. W. Gibbons & R. R. Sharitz (Eds). U. S. Atomic Energy Comm. Symposium Series (CONF- 730505). National Tech. Informational Service, Springfield, Virginia.

TIBBO, K. 1991. Thermoregulatory and social behaviour in muggers in captivity. Report submitted to Madras Crocodile Bank Trust, Vadanemmeli. 33 pp.

WEBB, G. J. W. & H. MESSEL. 1979. Wariness in *Crocodylus porosus*. *Australian Wildl. Res*. 6: 227-234.

WHITAKER, R. & J. C. DANIELS. 1980. The status of Indian crocodiles. *J. Bombay nat. Hist.* 75(suppl): 1238-1245.

________ & Z. WHITAKER. 1989. Ecology of mugger. *In*: Crocodiles: their ecology, management and conservation. pp: 276-296. IUCN, Gland.

Received: 30 January 2003.
Accepted: 22 July 2003.

Hamadryad Vol. 27, No. 2, pp. 248 – 253, 2003

CHROMOSOMAL SEX DETERMINATION IN ANURAN AMPHIBIANS

Samarendra Nath Banerjee[1] and Samar Chakrabarti[2]

[1]Department of Zoology, Rammohan College, 102/1, Raja Rammohun Sarani, Kolkata 700 009, India.
Email: samban2kcal@yahoo.com
[2]Cancer Cytogenetics Unit, Department of Zoology, Burdwan University, Burdwan 713 104, India.

ABSTRACT.– **The sex chromosome constitution in amphibians has been a conflicting issue, with the occurrence of heteromorphic sex chromosome being demonstrated in 55 species of the over 5,000 extant species. Among anurans, cytogenetically recognizable heteromorphic sex chromosomes have been found in only 27 species. Among Indian amphibians, heteromorphic sex chromosomes have been confirmed in four species.**

KEYWORDS.– **Sex chromosome, sex determination, amphibians, Heterochromatinization.**

The status of sex chromosomes and the mechanism of sex determination in amphibians had been an enigma for a long time. Amphibians, comprising three living Orders (Anura, Urodela and Gymnophiona) with 28 families and over 5,000 extant species, have attracted attention because of their ambiguous nature of sex chromosomes and sex determining mechanisms. The first successful demonstration of sex determining mechanism with non-cytogenetic methods was provided by Humphrey (1945) in the salamander *Ambystoma mexicanum* where the existence of female heterogamety and sex reversal phenomenon was noted. Pioneering Indian investigators tried to solve the riddle by some classical cytogenetic methods based on morphometric analysis (Manna and Bhunya, 1966; Chatterjee and Barik,1970; Mittal and Sawhney, 1971; Singh, 1974; Yadav and Pillai,1975). Female heterogamety in *Xenopus laevis* (Chang and Witschi, 1955) was first suggested by analysing the sex of the progeny of sex reversed individuals.This has been confirmed in *Xenopus* by the application of cell surface H-y antigen test (Wachtel et al.,1975). The introduction of banding technology and its application in amphibian cytology have opened a new avenue to approach the question of sex chromosomes in this group of vertebrates. Schmid et al. (1979) demonstrated the existence of heteromorphic sex chromosomes in male urodeles by C-banding technique. Contrary to this finding, a well differentiated heteromorphic ZW sex chromosome has also been reported in female anuran *Pyxicephalus adspersus* and *P. delalandii* (Schmid, 1980). Cytological evidence in favour of male heterogamety (XX/XY sex chromosome) in a leptodactylid frog *Eupsophus migueli* has been published by Iturra and Veloso (1981). Schempp and Schmid (1981) demonstrated the existence of XX/XY sex chromosome in *Rana esculenta* by BrdU-Hoechst Giemsa technique. The Y–chromosome of *R. esculenta* male exhibits no size differences with X but differs by possessing a small extremely late replicating region in the middle region of the long arm. In females of this species, both X-chromosomes replicate synchronously. C-banding and meiotic diakinesis study of males indicate that an xx/xy system of sex determination operates in *Hyperolius viridiflavus ommatostictus* (de Almeida et al., 1990). Female heterogamety in several Indian frogs, such as *Hoplobatrachus tigrinus, Euphlyctis cyanophlyctis* and *Rana tytleri* (as *R. erythraea*) has also been demonstrated by the application of C-banding technique (Chakrabarti et al., 1983; Banerjee, 1986; Banerjee and Chakrabarti, 1986; 1989). The

TABLE 1: Types of heterogamety (XX/XY as well as ZZ/ZW) in Anura demonstrated by cytogenetic and non-cytogenetic methods.

Species	Heterogamety	Methods	References
Family: Leiopelmatidae			
Leiopelma hochstetteri	OW-Female	C-banding method &	Green, 1988
	OO-Male	morphometric analysis	
L. hamiltoni	ZZ/ZW	C-banding method	Green, 1988
Family: Pipidae			
Xenopus laevis	ZZ/ZW	Sex revesal	Chang & Witschi, 1955
	ZZ/ZW	H-Y antigen test	Wachtel et al., 1975
Family: Myobatrachidae			
Crinia bilingua	ZZ/ZW	morphometric analysis	Mahony, 1991
Family: Leptodactylidae			
Eleutherodactylus maussi	XX/XY	C-banding method	Schmid et al., 1992
Eupsophus migueli	XX/XY	C-banding method	Iturra & Veloso, 1989
E. roseus	XX/XY	C-banding method	Iturra & Veloso, 1989
E. insularis	XX/XY	C-banding emthod	Cuevas & Formas, 1996
Family: Bufonidae			
Bufo melanostictus	ZZ/ZW	morphometric analysis	Manna & Bhunya, 1966
B. bufo	ZZ/ZW	hermaphrodites & H-Y antigen test	Ponse, 1942
Family: Hylidae			
Hyla arborea japonica	XX/XY	Sex reversal	Kawamura & Nishioka, 1977
Gastrotheca riobambae	XX/XY	C-banding method	Schmid et al., 1983
G ovifera	XX/XY	C-banding method	Schmid et al., 1988
G. walkeri	XX/XY	C-banding method	Schmid et al., 1988
G. pseustes	XX/XY	C-banding method	Schmid et al., 1990
Family: Hyperoliidae			
Hyperolius viridiflavus ommatostictus	XX/XY	C-banding & meiotic diakineses analysis	de Almeida et al., 1990
Family: Rhacophoridae			
Buergeria buergeri	ZZ/ZW	morphometric analysis Nucleolar organizer	Ohta, 1986
		C-banding method	Schmid et al., 1993
Family: Ranidae			
Rana pipiens	XX/XY	Sex reversal	Wachtel et al., 1975
R. ridibunda	XX/XY	Sex reversal	Witschi, 1929
	XX/XY	H-Y antigen test	Zaborski, 1979
Pyxicephalus adspersus	ZZ/ZW	C-banding method	Schmid, 1980
	ZZ/ZW	H-Y antigen test	Engel & Schmid, 1981
	ZZ/ZW	BrdU replication pattern	Schempp & Schmid, 1981
P. delalandii	ZZ/ZW	C-banding method	Schmid, 1980
Rana esculenta	XX/XY	BrdU Replication pattern	Schempp & Schmid, 1981
Hoplobatrachus tigerinus	ZZ/ZW	morphometric analysis	Yadav & Pillai, 1975
	ZZ.ZW	C-banding method	Chakrabarti et al., 1983; Banerjee, 1986
Euphlyctis cyanophlyctis	ZZ/ZW	morphometric analysis	Mittal & Sawhney, 1971; Yadav & Pillai, 1975
	ZZ/ZW	C-banding method	Banerjee & Chakrabarti, 1986; 1989
Rana tytleri (as *R. erythraea*)	ZZ/ZW	C-banding method	Banerjee & Chakrabarti, 1986

R. nigromaculata	XX/XY	Sex reversal	Kawamura & Nishioka, 1977
R. brevipoda	XX/XY	Sex reversal	Kawamura & Nishioka, 1977
Hoplobatrachus rugulosus	XX/XY	C-banding & BrdU Rep.	Nishioka & Hanada, 1994
	ZZ/ZW	C-banding & BrdU Rep.	Nishioka & Hanada, 1994
R. japonica	XX/XY	C-banding & BrdU Rep.	Miura, 1994
R. tagoi	XX/XY	C-banding & BrdU Rep.	Ryuzaki et al., 1999
R. sakuraii	XX/XY	C-banding & BrdU Rep.	Ryuzaki et al., 1999

W-chromosome of these species is composed almost wholly C-band positive constitutive heterochromatin.

The existence of highly differentiated XX/XY sex chromosome has been reported in *Gastrotheca riobambae* by Schmid et.al. (1983); *G. ovifera* and *G. walkeri* by Schmid et al. (1988), *G. pseustes* by Schmid et al. (1990), *Eleutherodactylus maussi* by Schmid et al. (1992). Morphologically distinguishable heteromorphic sex chromosome (ZW/ZZ) in the Australian frog *Crinia bilingua* (Anura; Myobatrachidae) was demonstrated by Mahony (1991) of which the W chromosome was large subtelocentric and the Z chromosome was small acrocentric. In *Buergeria buergeri* (Anura; Rhacophoridae), ZZ/ZW type of heteromorphic sex determination was demonstrated of which the Z-chromosome had a nucleolar organizer, while the W-chromosome had none (Ohta, 1986; Schmid et al., 1993). Chromosomal studies of the endemic New Zealand frog, *Leiopelma hochstertteri* have indicated the occurrence of unusual cytogenetic phenomenon- the OW female/OO male sex determination system (Green 1988). This type of sex determination system is a form of female heterogamety and probably originated from ZW/ZZ through loss of the Z chromosome. The chromosomes of *Hoplobatrachus rugulosus* have indicated the occurrence of both ZZ/ZW and XX/XY type of sex determination mechanism (Nishioka and Hanada, 1994). Chromosomes of *Eupsophus insularis* (Cuevas and Formas, 1996), *Rana tagoi* and *R. sakuraii* from Tokyo (Ryuzaki et al., 1999) show the occurrence of XX/XY system of sex determination.

Comparative cytogenetic investigations (e.g., different banding patterns) on vertebrates have shown that heterochromatinization of Y or W chromosomes is a decisive factor in the evolution of heteromorphic XY or ZW sex chromosomes (Ohno, 1976; Singh et al., 1967). Heterochromatinization, occurs due to accumulation of repetitive DNA sequences, successively covering the euchromatic regions of the Y and W chromosomes, respectively. According to Ohno (1967), the primary step in the evolution of sex specific chromosomes is the creation of an isolation mechanism. The differentiation of two heteromorphic sex specific chromosomes (Z and W or X and Y) evolves through chromosomal rearrangements during or after their heterochromatinization. Contrary to this, Singh et al. (1976) and Chakrabarti et al. (1983) gave priority to an initial heterochromatinization phenomenon. A majority of anuran karyotypes have similarly low chromosome numbers. The lists compiled by Kuramoto (1972, 1979, 1990) show that of 983 frog species examined, 816 (83.0%) have a chromosome complement of 2n = 22-26 chromosomes. Each family of anurans shows internally similar karyotypes (Kuramoto, 1990).

Till date, the occurrence of heteromorphic sex chromosome has been demonstrated in only 55 species of amphibians (both anurans and urodels) by the improved non-cytogenetic as well as cytogenetic methods (Schmid et al., 1983; Chakrabarti et al., 1983; Manna, 1983; Banerjee, 1986; Banerjee and Chakrabarti, 1989; Schmid et al., 1990; Nishioka and Hanada, 1994; Cuevas and Formas, 1996; Ryuzaki et al., 1999; Wallace et al., 1999). Among anurans, cytogenetically recognizable heteromorphic sex chromosomes have been found in only 27 species (Table 1). Among Indian amphibians, heteromorphic sex chromosomes have been confirmed only in four species. In these species still constitute a small sample when compared with the number of extant species of Amphibia, it becomes clear that in the Class Amphibia, both

types of chromosomal sex determining mechanism (XX/XY and ZZ/ZW) have evolved. Various degrees of varieties in sex chromosomes have been found among different species of the same family or different populations of the same species in anurans which are still in a primitive state of sex differentiation. The present authors are developing some techniques (C-banding method and BrdU labelling technique) for detection of heteromorphic sex chromosomes and sex determining mechanisms in Indian anuran which will contribute to knowledge of sex chromosomes.

Financial support of the University Grants Commission, ERO, Salt Lake, Calcutta (Project No.F. PSW-20/99 (ERO) 15 September 1999 is gratefully acknowledged. The first author is grateful to Suchisree Das, Jayashree Samanta and Samar Bhattacharya, Department of Zoology, Rammohan College, Kolkata, for encouragement.

LITERATURE CITED

BANERJEE, S. N. 1986. Chromosomal endophenotype of some Indian Anura with reference to C-band distribution and sensitivity of heterochromatin to induced aberration. Unpublished Ph. D. thesis, Burdwan University, Burdwan. 149 pp.

________& S. CHAKRABARTI. 1986. The present status of sex chromosomes in some Indian anurans. *Persp. Cytol. Genet.* 5: 119-124.

________&________ . 1989. Heteromorphic sex chromosomes in Indian water frog, *Rana cyanophlyctis* with notes on the distribution of C-band positive constitutive heterochromatin. *Genetica Polonica* 30: 176-180.

CHAKRABARTI, S., S. N. BANERJEE, L. N. NEOGI & S. ROY CHOWDHURY. 1983. C-band positive W-chromosome in female Indian frog. *Experientia* 39: 321-322.

CHANG, C. Y. & E. WITSCHI. 1955. Breeding of sex reversed males of *Xenopus laevis* Daudin. *Proc. Soc. Exp. Biol. Med*. 89: 150-152.

CHATTERJEE, K. & S. K. BARIK. 1970. A study of chromosomes of both sexes of the Himalayan toad *Bufo himalayanus* Günther. *Genen. en Phaenen*. 14: 1-3.

CUEVAS, C. C. & J. R. FORMAS. 1996. Heteromorphic sex chromosomes in *Eupsophus insularis* (Amphibia; Anura: Leptodactylidae). *Chromosome Res*. 4: 467-470.

DE ALMEIDA, C. G., T. U. GRAFE, M. GUTTENBACH & M. SCHMID. 1990. Karyotype and chromosome banding in the reed frog *Hyperolius viridiflavus ommatostictus* (Amphibia, Anura, Hyperoliidae). *Experientia* 46(5): 509-511.

ENGEL, W. & M. SCHMID. 1981. H-Y antigen as a tool for the determination of the heterogametic sex in Amphibia. *Cytogenet Cell Genet*. 30: 130-136.

GALLIEN, L. 1954. Démonstration de I' homogamétie du sexe mâle chez le triton *Pleurodeles waltlii* Michah. par l'étude de la descendance d'animaux à sexe physiologique inverse, après un traitement hormonal gynogène (benzoate d'oestradiol). *C.R. Acad. Sci*. 238: 402-404.

GREEN, D. M. 1988. Cytogenetics of the endemic New Zealand frog, *Leiopelma hochstetteri*: extraordinary supernumerary chromosome variation and a unique sex chromosome system. *Chromosoma* 97: 55-70.

HUMPHREY, R. R. 1945. Sex determination in ambystomid salamanders: a study of the progeny of females experimentally converted into males. *American J . Anat*. 76: 33-66.

ITURRA, P. & A. VELOSO. 1981. Evidence for heteromorphic sex chromosomes in male amphibians (Anura: Leptodactylidae). *Cytogenet. Cell Genet*. 31: 108.

________. 1989. Further evidence for early sex chromosome differentiation of anuran species. *Genetica* 78: 25 - 31.

KAWAMURA, T. & M. NISHIOKA.1977. Aspects of the reproductive biology of Japanese anurans. *In*: The reproductive biology of amphibians. pp: 103-139. D. H. Taylor & S. I. Guttman (Eds). Plenum Publishing Corporation, New York and London.

KURAMOTO, M. 1972. Karyotypes of the six species of frogs (genus *Rana*) endemic to the Ryukyu Islands. *Caryologia* 25: 547-559.

________. 1979. Karyotypes of several frogs from Korea, Taiwan and Philippines. *Experientia* 39: 826-827.

________. 1990. A list of chromosome numbers of anuran amphibians. *Bull. Fukuoka Univ. Educ. Part III* 39: 83-127.

MAHONY, M. J. 1991. Heteromorphic sex chromosomes in the Australian frog *Crinia bilingua* (Anura: Myobatrachidae). *Genome* 34: 334-337.

MANNA, G. K. 1983. Cytogenetic studies on fish and Amphibia. *In*: Genetical research in India. XV Int. Cong. Genet. pp: 243-273. P. L. Jaiswal (Ed). ICAR, New Delhi.

________& S. P. BHUNYA. 1966. A study of somatic chromosomes of both sexes of the common Indian toad, *Bufo melanostictus* by a new spleen technique. *Caryologia* 19: 403-407.

MITTAL, O. P. & V. SAWHNEY. 1971. Meiosis in two species of Anura from Chandigarh. *Proc. 58th Indian Sci. Cong. IV:* 634.

MIURA, I. 1994. Sex chromosome differentiation in the Japanese brown frog, *Rana japonica* I. Sex related heteromorphism of the distribution pattern of constitutive heterochromatin in chromosome no. 4 of the Wakuya population. *Zool. Sci.* 11: 797-806.

NISHIOKA, M. & H. HANADA. 1994. Sex of reciprocal hybrids between the Hamakita (XX-XY type) population and the Murakami (ZW-ZZ type) population of *Rana rugosa. Sci. Rep. Lab. Amphibian Biol., Hiroshima Univ*. 13: 35-50.

OHNO, S. 1967. Sex chromosomes and sex linked genes. Springer, Berlin, Heidelberg and New York. x + 192 pp.

OHTA, S. 1986. Sex determining mechanism in *Buergeria buergeri* (Schlegel). I. Heterozygosity of chromosome pair no. 7 in female. *Sci. Rep. Lab. Amphibian Biol., Hiroshima Univ*. 8: 29-43.

PONSE, K. 1942. Sur la digamétie du crapaud hermaphrodite. *Rev. Suisse Zool*. 49: 185.

RYUZAKI, M., H. HANADA, H. OKUMOTO, N. TAKIZAWA & M. NISHIOKA. 1999. Evidence for heteromorphic sex chromosomes in males of *Rana tagoi* and *Rana sakuraii* in Nishitama district of Tokyo (Anura, Ranidae). *Chromosome Res*. 7(1): 31-42.

SCHEMPP, W. & M. SCHMID. 1981. Chromosome banding in Amphibia. VI. BrdU-replication patterns in Anura and demonstration of XX/ XY sex chromosomes in *Rana esculenta*. *Chromosoma* 83: 697-710.

SCHMID, M. 1980. Chromosome banding in Amphibia. V. Highly differentiated ZW/ZZ sex chromosomes and exceptional genome size in *Pyxicephalus adspersus* (Anura, Ranidae). *Chromosoma* 80: 69-96.

________, T. HAAF, B. GIELE & S. SIMS. 1983. Chromosome banding in Amphibia. VIII. An unusual XY/XX sex chromosome system in *Gastrotheca riobambae* (Anura, Hylidae). *Chromosoma* 88: 69-82.

________, J. OLERT & C. KLETT. 1979. Chromosome banding in Amphibia. III. Sex chromosomes in *Triturus*. *Chromosoma* 71: 29-55.

________, S. OHTA, C. STEINLEIN & M. GUTTENBACH. 1993. Chromosome banding in Amphibia. XIX. Primitive ZW/ZZ sex chromosomes in *Buergeria buergeri* (Anura: Rhacophoridae). *Chromosoma* 62: 238-246.

________, C. STEINLEIN, W. FEICHTINGER, C. G. DE ALMEIDA & W. E. DUELLMAN. 1988. Chromosome banding in Amphibia. XIII. Sex chromosome, heterochromatin and meiosis in marsupial frogs. *Chromosoma* 97: 33- 42.

________,_________ & W. FEICHTINGER. 1992. Chromosome banding in Amphibia. XVII. First demonstration of multiple sex chromosome in amphibians: *Eleutherodactylus maussi* (Anura: Leptodactylidae). *Chromosoma* 101: 284-292.

________,_________ , R. FRIEDL, C. G. DE ALMEIDA, T. HAAF, D. M. HILLIS & W. E. DUELLMAN. 1990. Chromosome banding in Amphibia. XV. Two types of Y- chromosomes and heterochromatin hyper variability in *Gastrotheca pseustes* (Anura, Hylidae). *Chromosoma* 99: 413-423.

SESSIONS, S. K. 1980. Evidence for a highly differentiated sex chromosome heteromorphism in the salamander *Necturus maculosus* (Rafinesque). *Chromosoma* 77: 157-168.

SINGH, L. 1974. Present status of sex chromosomes in amphibians. *The Nucleus* 17(1): 17-27.

________, I. F. PURDOM & K. W. JONES. 1976. Satellite DNA and evolution of sex chromosomes. *Chromosoma* 59: 43 –62.

WACHTEL, S. S., G. C. KOO & E. A. BOYSE. 1975. Evolutionary conservation of H-Y (male) antigen. *Nature, London* 254: 270-272.

WALLACE, H., G. M. I. BADAWY & B. M. N. WALLACE. 1999. Amphibian sex determination and sex reversal. *Cell. Mol. Life. Sci*. 55: 901-909.

WITSCHI, E. 1929. Studies on sex differentiation and sex determination in amphibians. III. Rudimentary hermaphroditism and Y-chromosome in *Rana temporaria*. *J. Exp. Zool*. 54: 157-223.

YADAV, J. S. & R. K. PILLAI. 1975. Somatic karyotypes of two species of Indian frogs (Anura, Amphibia). *Cytobios* 13: 109-113.

ZABORSKI, P., M. DORIZZI & C. PIEAU. 1979. Sur l'utilisation de sérum anti H-Y de souris pour la détermination du sexe génétique chez *Emys orbicularis* L. (Testudines, Emydidae). *C. R. Acad. Sci*. 288: 351-354.

Received: 25 October 2000.
Accepted: 10 December 2002.

Hamadryad Vol. 27, No. 2, pp. 254, 2003

A case of albinism in *Kachuga tentoria circumdata* (Testudines: Bataguridae)

(with one text-figure)

Vyas (1997) reviewed albinism in Indian reptiles in the context of his report of albinism in the trionychid, *Lissemys punctata punctata.* All other examples cited by him were of albino snakes and his was the first report of an albino form in Indian turtles. We report albinism in an Indian batagurid turtle for the first time.

In September 2000, a hatchling pink-ringed tent turtle, *Kachuga tentoria circumdata* was brought to the Gharial Rehabilitation Center, Kukrail, near Lucknow in Uttar Pradesh. It was reportedly caught from the river Gomti at Aa'm Ghat in District Sultanpur, U.P. Measurements of the hatchling were as follows: straight carapace length 44.8 mm; carapace width 40.1mm; plastron length 40.4 mm; shell height 27.1 mm; and weight 17 gm.

Das (1991) describes the colouration of normal *K. tentoria circumdata* as, carapace olive green with a pink pleuro-marginal ring; plastron yellow with large dark blotches; head olive-green with a pink postocular spot and pink bars behind the eyes. The albino specimen being reported here was totally devoid of melanophoric colouration on any of its body parts and its pupils were reddish-pink. The pink iridiophoric pigmentation of the pleuro-marginal ring, and the postocular spots and bars were present. In the albino however, additional iridiophoric pigmentation was visible on the carapace as a vertebral line, along the sutures of the plastral scutes and along the junction of the bridge and the plastron. The carapace was suffused with xanthophoric (yellow) pigmentation. Such pigmentation in normal specimens, is masked by, or blends with melanophoric pigmentation.

FIGURE 1: Albino individual of *Kachuga tentoria circumdata* caught from the river Gomti at Aa'm Ghat, District Sultanpur, Uttar Pradesh.

Albinism in Indian batagurid turtles has not been reported before and is certainly rare among turtles of the Gomti and other northern Indian rivers. In our experience with these turtles spanning nearly three decades, none of us has ever observed the phenomenon before and the same is true for several fishermen familiar with turtles whom we interviewed after observing this specimen.

LITERATURE CITED

DAS, I. 1991. A colour guide to the turtles and tortoises of the Indian subcontinent. R & A Publishing Limited, Portishead. iv + 133 pp + 16 col. pl.

VYAS, R. 1997. An albino form of the Indian flapshell turtle *Lissemys punctata*. *Hamadryad* 22(1): 62-63.

Dhruvajyoti Basu[1], Sanjay Srivastava and Suresh Pal Singh,
Gharial Rehabilitation Centre, Kukrail Forest, Lucknow 226 022, India.
[1]Email: dhrubasu@rediffmail.com

Received: 28 August 2002.
Accepted: 14 April 2003.

Hamadryad Vol. 27, No. 2, pp. 255 – 256, 2003

Record of *Pterorana khare* Kiyasetuo and Khare, 1986 (Anura: Ranidae) from Aizwal District, Mizoram, north-eastern India

(with one text-figure)

Pterorana khare is an endemic monotypic ranid species from the north-eastern India, first reported from the Sonuoru and Rukhroma rivers, near Kohima, Nagaland, by Kiyasetuo and Khare (1986). Both localities are altitudes between 1,400-1,450 m above msl. (Chanda, 1994). Subsequently, Dutta (1997) and Pawar (1999) reported its presence from Manipur (locality not mentioned) and from the evergreen forests of Ngengpui Wildlife Sanctuary in Chimtuipui District of southern Mizoram, respectively.

The present specimen of *Pterorana khare* was collected from the bank of the river Tlwang (Sairang; 23°36'N; 93°00'E), 21 km from Aizwal in north-west Mizoram, at an altitude of 2,000-2,500 m above msl. and ca. 730 km from the type locality (Kohima). The frog was collected at the beginning of the winter season, on 29 November 2002, when the atmospheric temperature was 20-28°C. The Tlwang originates from the Lushai Hills, which extends as Arakan Yoma in Myanmar. The riverbed was strewn with stones and pebbles and water temperature was 15°C. The area is dominated by a profusion of natural vegetation and also includes mixed cropping of citrus, maize, beans and cucurbita.

Morphometric measurements were made using a vernier caliper and ruler (in mm): snout-vent length 66.5; head length 17.0; head width 23.0; maximum body width 37.5 (with skin flap); snout-narial distance 2.0; snout-orbit distance 10.0; internarial distance 7.0; interorbital distance 12.0 (at centre of orbit); eye diameter 8.0; tympanum diameter 3.0; femur length 35.0; tibia length 35.0; tibia width 10.0; fore limb length 35.0; and hind limb length 52.0. The specimen is preserved in the Museum of the Department of Zoology, P.U. College, Aizwal.

The specimen is a male (with testis), and shows a slate grey dorsum with coarsely granular skin surface; ventral surface cream-yellow with a dark grey shade. Although no granular tubercle was observed at angle of jaws, a distinct dorsolateral ridge (stripe) is present from posterior of torso, as described by Chanda (1994). Flanks of body with flaps of skin measuring ca.18.5 mm when fully extended (at the middle); each thigh with flaps of skin measuring 8 mm when fully spread; a flap of skin present over vent; head broader than long, depressed and snout rounded in dorsal view; upper jaw projects over lower jaw; tympanum fairly distinct and measures 3 mm in diameter; hind limbs overlap when folded at right angles to body; tibiotarsal articulation reaches snout; fingers lack webbing; tips are with oblong discs; subarticular tubercles prominent; toes fully webbed and tips dilated into oblong discs; subarticular tubercles distinct and oval shaped; an inner oblong and an outer rounded metatarsal tubercle present; and fingers

FIGURE 1: *Pterorana khare* Kiyasetuo and Khare, 1986 from Aizwal District, Mizoram, India (specimen in the Museum of Department of Zoology, P.U. College, Aizwal).

and toes in order of length are: 3 > 4 > 2 > 1 and 4 > 3 > 5 > 2 > 1, respectively.

Although Kiyasetuo and Khare (1986) recorded it to be an edible species in Nagaland, this species is not consumed in Mizoram, as reported by the local residents. The type series collected from Nagaland by Kiyasetuo and Khare (1986) and the present specimen were both collected from edges of mountainous rivers.

LITERATURE CITED

CHANDA, S.K. 1994. Anuran (Amphibia) fauna of northeast India. *Mem. Zool. Surv. India* 18(2): 1-vi +1-132; maps a-w.

DUTTA, S. K.1997. Amphibians of India and Sri Lanka (checklist and bibliography). Odyssey Publishing House, Bhubaneswar. (4) + xiii + 342 + xxii pp.

KIYASETUO & M. K. KHARE. 1986. A new genus of frog (Anura: Ranidae) from Nagaland at the northeastern hills of India. *Asian J. Exp. Sci*. 1: 12-17.

PAWAR, S. 1999. Effects of habitat alteration on herpetofaunal assemblages of evergreen forest in Mizoram, North-East India. Unpublished M. Sc. Dissertation, Saurastra University. 64 pp.

Mithra Dey[1] and S. N. Ramanujam[2],
[1]Department of Zoology, G. C. College,
Silchar 788 004, Assam, India.
Email: mithradey@rediffmail.com
[2]Department of Zoology, Pachhunga
University College, Aizwal 796 001,
Mizoram, India.

Received: 25 March 2003.
Accepted: 17 May 2003.

Hamadryad Vol. 27, No. 2, pp. 256 – 259, 2003

Ecology of ticks, including a new record of *Aponoma* (Ixodoidea: Ixodidae) from *Laticauda colubrina* on Loloata Island of Papua New Guinea

Laticaudines, such as the amphibious sea snake, *Laticauda colubrina* (Schneider) have been reported to have evolved their marine habitats independent of true sea snakes or Hydrophiines (Cogger and Zweifel, 1998; Keogh, 1998). The common name of the sea-krait comes from the resemblance of these snakes to land kraits, ringed terrestrial Asian venomous snakes of the genus *Bungarus*. These fixed front fanged sea snakes are also brightly ringed and found in oceans of the Indo-Pacific region. They have developed flattened paddle like tails enabling them to swim rapidly but have retained their cylindrical body shape like their terrestrial relatives. They have enlarged ventral scales for crawling on land (belly scales greatly reduced in size or absent in the hydrophiines) which they do to seek shelter to bask and to mate. The eggs are also laid on land and *Laticauda* can be found in large numbers on some tropical islands.

Ecological data, on the other hand, suggest that *Laticauda* evolved from an elapid stem much later than other Hydrophiines. This would explain their parasitic association with *Amblyomma* ticks (Yamaguti et al., 1971) which are lacking in other Hydrophiines and also the infestation of their air sacs by two species of highly host specific vermiform or maggot-like trombiculid mites, *Vatacarus ipoides* Southcott (in tidal reef off island at Singapore) and *Vatacarus kuntzi* Nadchatram and Radovsky (from island near Taiwan) which are endoparasites, unlike the typical chigger mites acarine in shape which attach to their hosts externally. These mites feed only in the larval stage and females without feeding and after fertilization produce eggs (Nadchatram and Radovsky, 1971).

A second species of ixodid tick, *Aponomma fimbriatum* Koch is reported here for the first

and toes in order of length are: 3 > 4 > 2 > 1 and 4 > 3 > 5 > 2 > 1, respectively.

Although Kiyasetuo and Khare (1986) recorded it to be an edible species in Nagaland, this species is not consumed in Mizoram, as reported by the local residents. The type series collected from Nagaland by Kiyasetuo and Khare (1986) and the present specimen were both collected from edges of mountainous rivers.

LITERATURE CITED

CHANDA, S.K. 1994. Anuran (Amphibia) fauna of northeast India. *Mem. Zool. Surv. India* 18(2): 1-vi +1-132; maps a-w.

DUTTA, S. K.1997. Amphibians of India and Sri Lanka (checklist and bibliography). Odyssey Publishing House, Bhubaneswar. (4) + xiii + 342 + xxii pp.

KIYASETUO & M. K. KHARE. 1986. A new genus of frog (Anura: Ranidae) from Nagaland at the northeastern hills of India. *Asian J. Exp. Sci*. 1: 12-17.

PAWAR, S. 1999. Effects of habitat alteration on herpetofaunal assemblages of evergreen forest in Mizoram, North-East India. Unpublished M. Sc. Dissertation, Saurastra University. 64 pp.

Mithra Dey[1] and S. N. Ramanujam[2],
[1]Department of Zoology, G. C. College,
Silchar 788 004, Assam, India.
Email: mithradey@rediffmail.com
[2]Department of Zoology, Pachhunga
University College, Aizwal 796 001,
Mizoram, India.

Received: 25 March 2003.
Accepted: 17 May 2003.

Hamadryad Vol. 27, No. 2, pp. 256 – 259, 2003

Ecology of ticks, including a new record of *Aponoma* (Ixodoidea: Ixodidae) from *Laticauda colubrina* on Loloata Island of Papua New Guinea

Laticaudines, such as the amphibious sea snake, *Laticauda colubrina* (Schneider) have been reported to have evolved their marine habitats independent of true sea snakes or Hydrophiines (Cogger and Zweifel, 1998; Keogh, 1998). The common name of the sea-krait comes from the resemblance of these snakes to land kraits, ringed terrestrial Asian venomous snakes of the genus *Bungarus*. These fixed front fanged sea snakes are also brightly ringed and found in oceans of the Indo-Pacific region. They have developed flattened paddle like tails enabling them to swim rapidly but have retained their cylindrical body shape like their terrestrial relatives. They have enlarged ventral scales for crawling on land (belly scales greatly reduced in size or absent in the hydrophiines) which they do to seek shelter to bask and to mate. The eggs are also laid on land and *Laticauda* can be found in large numbers on some tropical islands.

Ecological data, on the other hand, suggest that *Laticauda* evolved from an elapid stem much later than other Hydrophiines. This would explain their parasitic association with *Amblyomma* ticks (Yamaguti et al., 1971) which are lacking in other Hydrophiines and also the infestation of their air sacs by two species of highly host specific vermiform or maggot-like trombiculid mites, *Vatacarus ipoides* Southcott (in tidal reef off island at Singapore) and *Vatacarus kuntzi* Nadchatram and Radovsky (from island near Taiwan) which are endoparasites, unlike the typical chigger mites acarine in shape which attach to their hosts externally. These mites feed only in the larval stage and females without feeding and after fertilization produce eggs (Nadchatram and Radovsky, 1971).

A second species of ixodid tick, *Aponomma fimbriatum* Koch is reported here for the first

time to infest *Laticauda,* providing further evidence of the departure of this genus of snakes from true sea-snakes, the genus *Aponomma* in general is host specific to terrestrial snakes and varanid lizards (N. Wilson *in*: Zann et al., 1975).

Three small islets in Bootless Bay near Port Moresby in Papua New Guinea were examined for *Laticauda* sea snakes and their parasites. All data pertinent to three male and three female snakes collected on 2 October 1988 and to 10 sea snakes examined on 3 March 1989 were obtained from living animals on Loloata and the snakes then released. They were not examined for parasitic mites. Otherwise the individual of *Laticauda* collected on neighbouring Lion Island near Motupore and the three Loloata specimens collected on 27 September 1988 have been deposited as voucher specimens with the Museum of Biology, University of Papua New Guinea, James I. Menzies, Curator. The origin of the name Loloata (the island itself 1.2 km long and 300 m wide at the widest point) implies an island of one hill, and is a tourist resort for skin-diving, containing an area known for its coral reefs and underwater ship wrecks (World War Two American Boston [Havoc] bomber on the sand bottom and a 65.1 m Pacific gas wreck on a reef). The main building was a private residence up until the early 1960's, and 10 years later the island was established as a weekend resort. Two additional islands were also examined for sea snakes, namely Motupore (09º 32'S; 147º 17'E) and Lion having four scuttled wrecks. Environments found at Motupore include savannah, regeneration monsoon forest, mangrove, rocky shore, soft bottom marine, sea-grass communities and fringing and barrier reefs (McGregor and Huber, 1993). Loloata contains savannah, little forested area and no mangrove but there are rocky shores and sea-grass communities (Yokohama and Aioi, 1985).

Measurements of length and body temperature were made (Hal Hirth) on 10 sea snakes (3 March 1989), with aid of torch between 0700-2200 h. when snakes were actually foraging on the grounds outside of the Loloata lodge. More snakes were observed to come ashore on a high tide and some have been noted to remain on shore for more than one week (Dick Knight, pers. comm.). Acarines were removed from live snakes with the aid of forceps and preserved in 80% ETOH. Sea snakes were not observed on the island during daylight hours as their eggs could have been noted if this study had been made during the period from June to August as has been noted on islands near Singapore (Lim and Tat-Mong, 1989).

Loloata.- *Amblyomma nitidum* Hirst and Hirst. (Irian Jaya; Papua New Guinea [Wilson, 1970]. Singapore and Pacific islands; not reported in Australia.) Only female snakes, l m and over in length were parasitized. 1 June 1988, 2 mm (males), 27 ff. (females), 3 nn. (nymphs), (two larval ticks reared from eggs laid on 3 September from eggs laid the previous July), RML 119329, E. E. and Terry Frohm, coll.; 27 September 1988, 3 ff. under scales on venter, J. Hillary, coll.; 22 October 1988, 3 male, 3 female snakes (no ticks), T. Frohm coll.; 9 January 1989 (from a total of 5 *Laticauda* examined), l m under scales on dorsum, 1 f. crawling on body, 2 mm, 1 f. under scales on dorsum, l f. attached to flat part of the tail, E. E. & T. Frohm, coll.; 3 March 1989 (from 7 female and 3 male examined), 2 nn., l n., 2 ff. under middorsal scales, 1 n. attached to tail, 4 nn. under middorsal scales, 1 n. under middorsal scales, E. E. and Hal Hirth. coll. *Aponomma fimbriatum* (Koch), (Australia, Indonesia, Malaysia, Papua New Guinea, Philippines), (new record) 1 June 1988, l m. on middle of back between scales (RML 119329), E. E. & T. Frohm coll.

Lion Island.- *Am. nitidum*, 4 March 1989, 1 m., 1 f. on tail, 1 n., 1 f. under middorsal body scales, J. C. Pernetta, coll. A female *Laticauda* examined swimming in several feet of seawater was parasitized by a partially engorged female tick indicating that ticks can withstand immersion while their host is submerged (T. Frohm, pers. comm.).

Motupore.- *Amblyomma trimaculatum* (Lucas) (Australia, Indonesia and Papua New Guinea), 8 June 1988, l m. ex. *Morelia amethistina,* E. E. & T. Frohm, coll.; *Aponomma* sp. 26 July 1978, 1 larva ex. *Demansia papuensis*, T. Frohm, coll.

Mangrove tree holes or depressions in vegetation (Yamaguti et al., 1971; Pimento, 1972) as well as cracks in cliff faces or rock crevices above the water line (Nadchatram, 1979) and holes among coral on small islands (Lim and Tat-Mong, 1989; Kuntz, 1963) all have been discussed in the literature as terrestrial habitat for laticaudines. Mangrove tree holes, however, have not been mentioned in literature where there has been association with ticks or chigger mites. Mangroves were not present on Brunei (Das, 1992) Fiji (Pernetta, 1977) Taiwan (Kuntz, 1963), Singapore (Lim and Tat-Mong, 1989) or the Ishigaki in the Ryukyus of southern Japan where snakes were parasitized. Ticks and chiggers being terrestrial arthropods would require a dry soil environment for pre-ovoposition and for eggs to hatch and tree limbs suspended over water would not constitute a desirable habitat to permit ovoposition by female acari. Other species of mildly venomous mangrove snakes such as *Boiga dendrophila* have rarely been reported as parasitized by ticks. There is a record from Thailand by *Aponomma lucasi* Warburton (Tanskul et al., 1983) which is known in Malaysia as a two host tick (Nadchatram, 1979) on monitor lizards. Of the three small islets examined in this study only Motupore possesses a mangrove forest lying closer to the PNG mainland than the other two islands. Laticaudines have not been observed on Motupore (T. Frohm, pers. comm.) for as long as the University has maintained its research station there (1969). It would seem that *Laticauda* at least in Bootless Bay, prefers habitat with fewer trees (forest is more dense on Motupore) where navigation on land would be easier for a sea snake and where there would be fewer predators with less vegetation that could conceal other predatory snakes or monitor lizards.

Small islands on the other hand with little or no forested habitat would be less desirable for other tick species such as *Aponomma fimbriatum* that parasitizes terrestrial snakes such as *Demansia* sp. or monitor lizards, such as *Varanus gouldi* in Australia (Roberts, 1970) or *V. indicus* reportedly from Malaysia. *Aponomma trimaculatum* also parasitizes snakes such as the Amethystine python in Australia and the monitor lizards *V. indicus* in West Irian, the Maluku and Seram in eastern Indonesia and New Ireland of Papua New Guinea (Roberts, 1970). This author also found *Dendrelaphis* sp. parasitized (2 ff on neck, 2 ff on lateral side of body underscales) at Wau in Morobe Province, PNG on 20 January 1989. As far as the author is aware there is no evidence of snake bite to man for *Laticauda colubrina* locally, On Loloata, tourists and resort personnel have no fear of snake bite even though sea snakes are commonly observed crawling on the premises outside of buildings in evening hours after night fall. Sea snakes made no attempt to bite Hal Hirth who handled them in this study. On Ishigaki, in the Ryukyus, children have been observed capturing these snakes which made no attempt to bite even when dragged along the ground by their tails (Keegan, 1960).

The author was a Fulbright Scholar at the University of Papua New Guinea in Port Moresby during 1988-1989 when these investigations were undertaken. James Keirans, Department of Arthropology and Parasitology, Georgia Southern University, Statesboro, Georgia determined the identity of *Am. nitidum* and *Ap. fimbriatum* (RML 119329) and *Ap. trimaculatum*. The author would also like to thank Hal Hirth, Biology Department, University of Utah, Salt Lake City, for assistance in handling live sea snakes at Loloata on 3 March 1989 and to Terry Frohm, former Superintendent of Motupore Biological Station for supplying transport to and from the islands on numerous occasions and for collecting *Laticauda.* Dick Knight, owner of Loloata lodge allowed us to examine live sea snakes on hotel grounds.

LITERATURE CITED

COGGER, H. G. & R. G. ZWEIFEL. 1998. Encyclopedia of reptiles & amphibians. Academic Press, London and New York. 240 pp.

DAS, I. 1992. Notes on egg sizes and ticks of the yellow-lipped sea krait (*Laticauda colubrinus*) on Pulau Punyit, Brunei Darussalam. *Hamadryad* 17: 45-46.

KEEGAN, H. L. 1960. Some venomous and noxious animals of the Far East. Medical General

Laboratory, U. S. Army Medical Command, Japan, San Francisco. 46 pp.

KEOGH, J. S. 1998. Molecular phylogeny of elapid snakes and a consideration of their biogeographic history. *Biol. J. Linnean Soc*. 63: 177-203.

KUNTZ, R. E. 1963. Snakes of Taiwan. *Q. J. Taiwan Mus*. 16(1 & 2): 1-79.

LIM, F. L. K. & M. L. TAT-MONG.1989. Fascinating snakes of southeast Asia- an introduction. Tropical Press. Kuala Lumpur. 124 pp.

McGREGOR, K. R. & M. E. HUBER. 1993. A bibliography of research related to Motupore Island, Papua New Guinea. *Sci. New Guinea* 19(2): 59-76.

NADCHATRAM, M. 1979. Ectoparasites of Malaysian snakes. *Malayan nat. J*. 33(1): 75-78.

________& F. J. RADOVSKY 1971. A second species of *Vatacarus* (Prostigmata, Trombiculidae) infesting the tracheae of amphibious sea-snakes. *J. Medical Entomol*. 8(1): 37-40.

PERNETTA, J. C. 1977. Observations on the habits and morphology of the sea-snake, *Laticauda colubrina* (Schneider) in Fiji. *Canadian J. Zool*. 55(10): 1612-1619.

PIMENTO, R. J. 1972. Some notes on the sea-snake, *Laticauda colubrina* (Schneider). *J. Bombay nat. Hist. Soc*. 69(1): 191-192.

ROBERTS, F. H. S. 1970. Australian ticks. Commonwealth Scientific and Industrial Research Organization, Canberra. 267 pp.

TANSKUL, P., H. E STARK & I. INLAO. 1983. A checklist of ticks of Thailand (Acari: Metastigmata: Ixodoidea). *J. Medical Entomol*. 20(3) 330-341.

WILSON, N. 1970. New distributional records of ticks from southeast Asia and the Pacific. (Metastigmata: Argasidae, Ixodidae). *Oriental Insects* 4(1): 37-46.

YAMAGUTI, N., V. J. TIPTON, H. L. KEEGAN & S. TOSHIOKA. 1971. Ticks of Japan, Korea, and the Ryukyu Islands. *Brigham Young Univ. Sci. Bull*. 15(1): 1-236.

YOKOHAMA, Y. & K. AIOI. 1985. Production of tropical seagrasses of Loloata Island in Papua New Guinea. 3rd Annual Motupore Island Research Dept. Workshop. Mimeo.

ZANN, L. P., R. J. CUFFEY & C. KROPACH. 1975. Fouling organisms and parasites associated with the skin of sea snakes. *In:* The biology of sea snakes. pp: 251-265. W. A. Dunson (Ed). University Park Press, University Park, Pennsylvania.

Emmett R. Easton, Hawaiian Entomological Society, University of Hawaii, 3050, Maile Way, Gilmore 310, Honolulu, HI 96822, U.S.A. Email: emmetteaston@hotmail.com.

Received: 25 March 2003.
Accepted: 9 July 2003.

Hamadryad Vol. 27, No. 2, pp. 259 – 262, 2003

First report of the herpetofauna of Pulau Tinggi, Johor, West Malaysia

Pulau Tinggi is a small island (17 km^2), located 32 km south-east of the coastal town of Mersing, in Johor, West Malaysia, and forms part of the southern section of the Seribuat Archipelago in the South China Sea. Of the 13 islands in the state of Johor, Pulau Tinggi has the highest peak at 625 m above sea level. This mountainous and largely uninhabited island is dissected by many small streams, and its coastline is characterised by white sandy beaches and many caves. With the exception of minor logging on the lower periphery of the west coast, the interior of the island consists of primary forest with closed canopy but lacks large granitic boulders found on the outer islands of the Seribuat Archipelago Pulau Tioman (Day, 1990; Grismer et al., 2002; Hendrickson, 1966a,b; Lim and Lim, 1999), its neighboring island Pulau Tulai (Hendrickson 1966a; Grismer et al., 2001b; Pulau Aur (Grismer et al., 2001a), and Pulau Pemanggil (Youmans et al., 2002).

Although the herpetofauna of the outer islands has been thoroughly examined, (Pulau Tioman: Day, 1990; Grismer et al., 2002; Hendrickson, 1966a,b; Lim and Lim, 1999; Pulau Tulai: Hendrickson 1966a; Grismer et al., 2001b; Pulau Aur: Grismer et al., 2001a; Escobar

Laboratory, U. S. Army Medical Command, Japan, San Francisco. 46 pp.

KEOGH, J. S. 1998. Molecular phylogeny of elapid snakes and a consideration of their biogeographic history. *Biol. J. Linnean Soc*. 63: 177-203.

KUNTZ, R. E. 1963. Snakes of Taiwan. *Q. J. Taiwan Mus*. 16(1 & 2): 1-79.

LIM, F. L. K. & M. L. TAT-MONG.1989. Fascinating snakes of southeast Asia- an introduction. Tropical Press. Kuala Lumpur. 124 pp.

McGREGOR, K. R. & M. E. HUBER. 1993. A bibliography of research related to Motupore Island, Papua New Guinea. *Sci. New Guinea* 19(2): 59-76.

NADCHATRAM, M. 1979. Ectoparasites of Malaysian snakes. *Malayan nat. J*. 33(1): 75-78.

________& F. J. RADOVSKY 1971. A second species of *Vatacarus* (Prostigmata, Trombiculidae) infesting the tracheae of amphibious sea-snakes. *J. Medical Entomol*. 8(1): 37-40.

PERNETTA, J. C. 1977. Observations on the habits and morphology of the sea-snake, *Laticauda colubrina* (Schneider) in Fiji. *Canadian J. Zool*. 55(10): 1612-1619.

PIMENTO, R. J. 1972. Some notes on the sea-snake, *Laticauda colubrina* (Schneider). *J. Bombay nat. Hist. Soc*. 69(1): 191-192.

ROBERTS, F. H. S. 1970. Australian ticks. Commonwealth Scientific and Industrial Research Organization, Canberra. 267 pp.

TANSKUL, P., H. E STARK & I. INLAO. 1983. A checklist of ticks of Thailand (Acari: Metastigmata: Ixodoidea). *J. Medical Entomol*. 20(3) 330-341.

WILSON, N. 1970. New distributional records of ticks from southeast Asia and the Pacific. (Metastigmata: Argasidae, Ixodidae). *Oriental Insects* 4(1): 37-46.

YAMAGUTI, N., V. J. TIPTON, H. L. KEEGAN & S. TOSHIOKA. 1971. Ticks of Japan, Korea, and the Ryukyu Islands. *Brigham Young Univ. Sci. Bull*. 15(1): 1-236.

YOKOHAMA, Y. & K. AIOI. 1985. Production of tropical seagrasses of Loloata Island in Papua New Guinea. 3rd Annual Motupore Island Research Dept. Workshop. Mimeo.

ZANN, L. P., R. J. CUFFEY & C. KROPACH. 1975. Fouling organisms and parasites associated with the skin of sea snakes. *In:* The biology of sea snakes. pp: 251-265. W. A. Dunson (Ed). University Park Press, University Park, Pennsylvania.

Emmett R. Easton, Hawaiian Entomological Society, University of Hawaii, 3050, Maile Way, Gilmore 310, Honolulu, HI 96822, U.S.A. Email: emmetteaston@hotmail.com.

Received: 25 March 2003.
Accepted: 9 July 2003.

Hamadryad Vol. 27, No. 2, pp. 259 – 262, 2003

First report of the herpetofauna of Pulau Tinggi, Johor, West Malaysia

Pulau Tinggi is a small island (17 km^2), located 32 km south-east of the coastal town of Mersing, in Johor, West Malaysia, and forms part of the southern section of the Seribuat Archipelago in the South China Sea. Of the 13 islands in the state of Johor, Pulau Tinggi has the highest peak at 625 m above sea level. This mountainous and largely uninhabited island is dissected by many small streams, and its coastline is characterised by white sandy beaches and many caves. With the exception of minor logging on the lower periphery of the west coast, the interior of the island consists of primary forest with closed canopy but lacks large granitic boulders found on the outer islands of the Seribuat Archipelago Pulau Tioman (Day, 1990; Grismer et al., 2002; Hendrickson, 1966a,b; Lim and Lim, 1999), its neighboring island Pulau Tulai (Hendrickson 1966a; Grismer et al., 2001b; Pulau Aur (Grismer et al., 2001a), and Pulau Pemanggil (Youmans et al., 2002).

Although the herpetofauna of the outer islands has been thoroughly examined, (Pulau Tioman: Day, 1990; Grismer et al., 2002; Hendrickson, 1966a,b; Lim and Lim, 1999; Pulau Tulai: Hendrickson 1966a; Grismer et al., 2001b; Pulau Aur: Grismer et al., 2001a; Escobar

et al., 2003; and Pulau Pemanggil: Youmans et al., 2002), this is the first published report of the herpetofauna of Pulau Tinggi. A total of 15 species were confirmed: two species of ranids, one rhacophorid, four species of gekkonids, two species of scincids, five species of agamids, and one colubrid. An additional species of snake and one gecko were observed but were not collected or photographed and therefore remain unconfirmed sightings.

Collecting was conducted with the intention of obtaining a preliminary list of the species present, and to obtain tissue samples of representative specimens. Collections were made by hand and blowpipe during the afternoon (1300-1700 h) and evening (1900-2300 h) of 23 July 2002 on the southeast side of the island, in the village of Pasir Panjang, the Pasir Panjang jungle trail, and Pasir Panjang waterfall trail and stream (02º 17'N; 109º 06'E). Tissue samples of liver were taken and stored in 100% ethanol. Specimens were preserved in 10% formalin and stored in 70% ethanol. Museum acronyms are ZRC = Zoological Reference Collection, at the Raffles Museum of Biodiversity Research, National University of Singapore, Singapore; LSUPC = La Sierra University Photographic Collection at the Department of Biology, La Sierra University, Riverside, California, 92515-8247.

Anura

Limnonectes blythii (Boulenger, 1920) (ZRC.1.10036).- Individuals were observed during the day along a moderately-flowing rocky stream with small waterfalls that ran through primary forest. One was collected at night on rocks next to the stream.

Polypedates leucomystax (Gravenhorst, 1829) (ZRC.1.10038).- Several individuals were observed at night on vegetation next to an overflowing reservoir behind the village. One specimen was collected.

Rana hosii Boulenger 1891, (ZRC.1.10037).- Several individuals were observed during the day along a moderately-flowing stream with small waterfalls that ran through primary forest. One individual was observed diving from a 4 m high perch into the stream to escape. One specimen was collected at night from this stream, and others were observed burrowing into the leaf litter at the bottom of streams to escape.

Squamata (Lizards)

Aphaniotis fusca (Peters, 1864) (ZRC.2.5496).- Several individuals were observed during the day on trees 2-4 m above ground level. At night they were observed sleeping on the lower foliage of trees. One specimen was collected.

Bronchocela cristatella (Kuhl, 1820) (ZRC.2.5497).- A single individual was observed along the jungle trail, 3 m above ground level on the side of a large tree (2 m diameter) next to dense shrubs.

Cnemaspis kendallii (Gray, 1845) (ZRC.2.5526).- Several individuals were observed during the day on rocks and in small caves in the vicinity of the stream bed. During the night they were observed on vegetation. One was collected.

Cosymbotus craspedotus (Mocquard, 1890)(LSUPC-L6091).- One individual was observed 2.5 m up a tree at the beginning of the Pasir Panjang jungle trail. The specimen avoided capture by crawling high into a crevice at the top of the tree.

Dasia olivacea Gray, 1839, (ZRC.2.5500).- Several individuals were observed during the day on salt cedar trees (*Tamarisk* sp.) along the beach. Many avoided capture by crawling to the top of the tree or by hiding on the upper sides of branches. One specimen was collected.

Draco formosus Boulenger, 1900, (ZRC.2.5502).- Several individuals were observed during the day approximately 4-10 m above ground level on large trees in primary forest.

Draco melanopogon Boulenger, 1887, (ZRC.2.5494).- Several individuals were observed 2-6 m above ground level on trees.

Draco sumatranus Schlegel, 1844, (ZRC.2.5495).- Several specimens were observed during the day, 4-8 m above ground level on coconut palms and dipterocarp trees along the periphery of the forest near water sources. None were observed within the primary forest.

Gekko monarchus (Duméril & Bibron, 1836) (ZRC.2.5501).- One individual was observed

during the day in rock caves near the waterfall. Several specimens were observed at night along the trail on trees, and in the caves near the waterfall. One specimen observed at night fell from a tree and landed on a students shoulder.

Hemidactylus frenatus Duméril & Bibron 1836, (ZRC.2.5498).- Specimens were observed and collected during the day while turning boards and rocks along the beach in Pasir Panjang village. Several individuals were also observed at night on walls in the village.

Mabuya multifasciata (Kuhl, 1820) (ZRC.2.5499).- One specimen was collected within the waterfall stream. It first avoided capture by submerging itself in the stream, but was caught when it came up approximately 1.5 m upstream from were it originally submerged itself. Other specimens were observed foraging in the vicinity of human habitation.

Ptychozoon kuhlii (Stejneger, 1902).- One individual was observed basking 6 m high along the trunk of a large dipterocarp tree. The individual was not collected or photographed and remains an unconfirmed sighting.

Squamata (Snakes)

Ahaetulla prasina (Boie, 1827) (LSUPC-S3610).- A single individual was observed during the day on the forest floor while it crossed the Pasir Panjang jungle trail.

Dendrelaphis sp..- A pair was observed 2 m above ground level on a small tree that was 2 m from the jungle trail. As they were approached, they launched themselves onto the forest floor and escaped downhill in the direction of the stream before being identified.

This report on the herpetofauna of Pulau Tinggi is preliminary, being that only a small portion of the island was sampled (Pasir Panjang village, jungle trail, and waterfall trail and stream) for a single afternoon and evening. Therefore, the species mentioned are considered only a subset of the total island diversity. All species reported from Pulau Tinggi occur on the much larger Pulau Tioman with the exception of *Draco formosus*. Although only three species of *Draco* have been found on Pulau Tinggi, *D. formosus, D. melanopogon* and *D. sumatranus*, we suspect that due to the rich forest habitat, additional species such as *D. fimbriatus* will be found. The absence of the common saxicolous skink *Sphenomorphus scotophilus* may be due to a lack of large granitic boulders in the forest habitat. This may also account for the absence of a large endemic species of *Cnemaspis* such as occurs on Pulau Tulai and Pulau Tioman (*Cnemaspis* sp. Das and Grismer 2003), Pulau Aur (*Cnemaspis* sp. Das and Grismer 2003), and Pulau Pemanggil (*Cnemaspis* sp. Grismer et al., in prep). Future sampling of the herpetofauna of this island is being planned.

This research was conducted as part of a field biology course Biology 487F: Tropical Field Biology taught by L. Lee Grismer, J. L. Grismer, H. Kaiser, and J. A. McGuire at La Sierra University. We would like to thank Sahir bin Othman, Director of Research and Conservation Division, PERHILITAN, for permission to conduct field work in the Seribuat Archipelago and Peter Kee Lin Ng, Chang Man Yang and Kelvin Kok Peng Lim for permitting us to examine material under their care.

LITERATURE CITED

DAS, I. & L. L. GRISMER. 2003. Two new species of *Cnemaspis* Strauch 1887 (Squamata: Gekkonidae) from the Seribuat Archipelago, Pahang and Johor states, West Malaysia. *Herpetologica*

DAY, M. 1990. Zoological research. *In*: University of Bristol Tioman Archipelago Expedition, Peninsular Malaysia, 1988. Final report. pp: 25-43. M. Day & T. Mowbrey (Eds). Unpublished Report.

ESCOBAR, R. A., J. CASTRO, D. MORGAN, S. M. HOVER, T. R. SZUTZ, K. McCLOSKEY, RICK GREGORY. 2003. Additions to the herpetofauna of Pulau Aur, Johor, West Malaysia. *Hamadryad* 27(2): 287-288.

GRISMER, L. L., N. S. YAAKOB, B. L. LIM, T.-M. LEONG, I. DAS, R. A. SOSA, J. L. GRISMER, K. M. CRANE, R. E. DIAZ, S. V. FIGUEROA, C. A. LEDBETTER, S. C. NEWBOLD, S. R. NEWBOLD, C. P. PATEL, J. CASTRO, R. A. ESCOBAR, III, S. GUERRERO, J. W. PINEDO, P. A. JONES & H. KAISER. 2001a. First report on the herpetofauna of Pulau

Aur, Johor, West Malaysia. *Hamadryad* 26(2): 350-353.

________, N. S. YAAKOB, B. L. LIM, T.-M. LEONG, I. DAS, R. A. SOSA, J. L. GRISMER, K. M. CRANE, R. E. DIAZ, S. V. FIGUEROA, C. A. LEDBETTER, S. C. NEWBOLD, S. R. NEWBOLD, C. P. PATEL, J. CASTRO, R. A. ESCOBAR III, S. GUERRERO, J. W. PINEDO, P. A. JONES & H. KAISER. 2001b. Report on the herpetofauna of Pulau Tulai, West Malaysia. *Hamadryad* 26(2): 364-371.

________, J. A. McGUIRE, R. A. SOSA & H. KAISER. 2002. Revised checklist and comments on the terrestrial herpetofauna of Pulau Tioman, Peninsular Malaysia. *Herpetol. Rev*. 33(1): 26-29.

HENDRICKSON, J. R. 1966a. Observations on the fauna of Pulau Tioman and Pulau Tulai. 5. The reptiles. *Bull. Nat. Mus. Singapore* 34: 53-71.

________. 1966b. Observations on the fauna of Pulau Tioman and Pulau Tulai. 6. The amphibians. *Bull. Nat. Mus. Singapore* 34: 72-84.

LIM, K. K. P. & L. J. LIM. 1999. The terrestrial herpetofauna of Pulau Tioman, Peninsular Malaysia. *Raffles Bull. Zool*. Suppl. 6: 131-155.

YOUMANS, T. M., R. E. ESCOBAR, III, J. L. GRISMER, L. L. GRISMER & R. JOHNSON. 2003. First report on herpetofauna of Pulau Pemanggil. *Hamadryad* 27(1): 148-149.

Ricardo A. Escobar, III[1], Jesse L. Grismer[2], Timothy M. Youmans[3], Perry L. Wood[4], Seth D. Kendall[5], J. Castro[1], T. Magi, C. Rasmussen, T. R. Szutz, S. M. Hover, D. Morgan, C. Raynor, K. McCloskey, N. Izvernari, A. Hunter, J. M. Bernard, N. Hinojosa[1], T. Dyer, J. Anlauf, J. Martinez, S. Andreiko, R. Gregory, L. S. Yeen, W. Wuertz, H. Kaiser[1] and L. Lee Grismer, Department of Biology, La Sierra University, Riverside, California 92515-8247, U.S.A.
Emails: ricaesco@hotmail.com[1], jessgris@lasierra.edu[2], timoyoum@lasierra.edu[3], perrwood@lasierra.edu[4], bobbidigtl@gmx.com[5]

Received: 15 October 2002.
Accepted: 4 February 2003.

Hamadryad Vol. 27, No. 2, pp. 262 – 265, 2003

A reinterpretation of the agamid genus *Mantheyus* Ananjeva and Stuart, 2001, as a junior synonym of *Ptyctolaemus* Peters, 1864, with comments on the problem of monotypic genera

Recently, Ananjeva and Stuart (2001) erected a new monotypic genus to accommodate the south-east Asian agamid lizard *Ptyctolaemus phuwuanensis* Manthey and Nabhitabhata, 1991, and to separate it from its original congener *P. gularis* Peters, 1864. The arguments for this generic partition were based on a reexamination of the scarce material of these two species which are both extremely rare in collections.

The problem that led us to submit the present note was that Ananjeva and Stuart (2001) interpreted the undoubtedly existing morphological differences between the two rare agamid species in a purely phenetic manner, and that they did not deal with the conceptual background of the notion of the genus in zoology. In spite of the existence of a diversity of species concepts, a widely accepted definition of what a genus is, is largely lacking, and only few trials have been made to put the notion of the genus concept on a less arbitrary basis (e.g., Dubois, 1988). In order to promote such a discussion, we want to make the following points:

1. The monophyly of all species accommodated in one genus is an indispensable prerequisite.

2. In a Hennigian sense (see Hennig, 1950, 1966), the morphological characters by which a genus is defined must be synapomorphies and not plesiomorphic character states.

3. But if apomorphic characters are used to define genera, they should not be obvious, environment-correlated adaptations, because in this case, morphological divergence may lead to an overestimation of the (phylo)genetic distance (see below).

4. It must be borne in mind that the conceptual purpose of the genus as a hierarchical category in our binary nomenclatural system is primarily to link related species together, so that a monotypic

Aur, Johor, West Malaysia. *Hamadryad* 26(2): 350-353.

________, N. S. YAAKOB, B. L. LIM, T.-M. LEONG, I. DAS, R. A. SOSA, J. L. GRISMER, K. M. CRANE, R. E. DIAZ, S. V. FIGUEROA, C. A. LEDBETTER, S. C. NEWBOLD, S. R. NEWBOLD, C. P. PATEL, J. CASTRO, R. A. ESCOBAR III, S. GUERRERO, J. W. PINEDO, P. A. JONES & H. KAISER. 2001b. Report on the herpetofauna of Pulau Tulai, West Malaysia. *Hamadryad* 26(2): 364-371.

________, J. A. McGUIRE, R. A. SOSA & H. KAISER. 2002. Revised checklist and comments on the terrestrial herpetofauna of Pulau Tioman, Peninsular Malaysia. *Herpetol. Rev*. 33(1): 26-29.

HENDRICKSON, J. R. 1966a. Observations on the fauna of Pulau Tioman and Pulau Tulai. 5. The reptiles. *Bull. Nat. Mus. Singapore* 34: 53-71.

________. 1966b. Observations on the fauna of Pulau Tioman and Pulau Tulai. 6. The amphibians. *Bull. Nat. Mus. Singapore* 34: 72-84.

LIM, K. K. P. & L. J. LIM. 1999. The terrestrial herpetofauna of Pulau Tioman, Peninsular Malaysia. *Raffles Bull. Zool*. Suppl. 6: 131-155.

YOUMANS, T. M., R. E. ESCOBAR, III, J. L. GRISMER, L. L. GRISMER & R. JOHNSON. 2003. First report on herpetofauna of Pulau Pemanggil. *Hamadryad* 27(1): 148-149.

Ricardo A. Escobar, III[1], Jesse L. Grismer[2], Timothy M. Youmans[3], Perry L. Wood[4], Seth D. Kendall[5], J. Castro[1], T. Magi, C. Rasmussen, T. R. Szutz, S. M. Hover, D. Morgan, C. Raynor, K. McCloskey, N. Izvernari, A. Hunter, J. M. Bernard, N. Hinojosa[1], T. Dyer, J. Anlauf, J. Martinez, S. Andreiko, R. Gregory, L. S. Yeen, W. Wuertz, H. Kaiser[1] and L. Lee Grismer, Department of Biology, La Sierra University, Riverside, California 92515-8247, U.S.A.
Emails: ricaesco@hotmail.com[1], jessgris@lasierra.edu[2], timoyoum@lasierra.edu[3], perrwood@lasierra.edu[4], bobbidigtl@gmx.com[5]

Received: 15 October 2002.
Accepted: 4 February 2003.

Hamadryad Vol. 27, No. 2, pp. 262 – 265, 2003

A reinterpretation of the agamid genus *Mantheyus* Ananjeva and Stuart, 2001, as a junior synonym of *Ptyctolaemus* Peters, 1864, with comments on the problem of monotypic genera

Recently, Ananjeva and Stuart (2001) erected a new monotypic genus to accommodate the south-east Asian agamid lizard *Ptyctolaemus phuwuanensis* Manthey and Nabhitabhata, 1991, and to separate it from its original congener *P. gularis* Peters, 1864. The arguments for this generic partition were based on a reexamination of the scarce material of these two species which are both extremely rare in collections.

The problem that led us to submit the present note was that Ananjeva and Stuart (2001) interpreted the undoubtedly existing morphological differences between the two rare agamid species in a purely phenetic manner, and that they did not deal with the conceptual background of the notion of the genus in zoology. In spite of the existence of a diversity of species concepts, a widely accepted definition of what a genus is, is largely lacking, and only few trials have been made to put the notion of the genus concept on a less arbitrary basis (e.g., Dubois, 1988). In order to promote such a discussion, we want to make the following points:

1. The monophyly of all species accommodated in one genus is an indispensable prerequisite.

2. In a Hennigian sense (see Hennig, 1950, 1966), the morphological characters by which a genus is defined must be synapomorphies and not plesiomorphic character states.

3. But if apomorphic characters are used to define genera, they should not be obvious, environment-correlated adaptations, because in this case, morphological divergence may lead to an overestimation of the (phylo)genetic distance (see below).

4. It must be borne in mind that the conceptual purpose of the genus as a hierarchical category in our binary nomenclatural system is primarily to link related species together, so that a monotypic

genus is only justified if it is meant to express the existence of a very long and isolated evolutionary line of a particular species without close relatives.

Points 2 and 4 provoke our criticism of the erection of *Mantheyus* by the above-cited authors. Their main argument for splitting *phuwuanensis* from the (formerly likewise monotypic) genus *Ptyctolaemus* is that Manthey and Nabhitabhata's species has femoral glands whereas *P. gularis* does not (Ananjeva and Stuart, op. cit.). However, femoral glands or pores, although widely distributed among lizard families, are plesiomorphic in agamids, being retained only in the genera *Leiolepis, Uromastyx, Hydrosaurus, Physignathus* and in the Australian agamid radiation (except *Chelosania* and *Moloch*) (Moody 1980). They are lacking throughout the members of the draconine and agamine clades (sensu Macey et al., 2000). That *phuwuanensis* retains femoral glands does not, however, argue against its affiliation as a basal member of the draconine clade ("group V" sensu Moody, 1980). However, only *phuwuanensis* has been included in a modern phylogenetic analysis using molecular data (Honda et al., 2000 a, b; 2002). The latter analysis suggests a basal position of *P. phuwuanensis* in the draconine divergence, although bootstrap support is rather weak. *P. gularis* was not included in any of these analyses. In any case, the posession of femoral pores in the former does not justify its accommodation in a different, monotypic genus.

The additional differences between *P. gularis* and *P. phuwuanensis* as discussed by Ananjeva and Stuart (2001) are also not suitable for a generic partition. Different scale counts are to be expected between even congeneric species, and a differently shaped gular sac may further corroborate the existence of two species (which we do not deny). Examination of the two species in the Berlin Museum (specimen no. ZMB 5004. 49041, Museum f. Naturkunde Berlin) corroborates differences between the two species. However, the peculiar longitudinal gular folding in both *Ptyctolaemus* species is unique. We do not deny differences, as noted by Ananjeva and Stuart (2001) in the form of folding and colouration (slightly rounded with red, yellow and black pigment in *phuwuanensis* versus linear with black pigment, without transversal gular fold in *gularis*). But even the parallel longitudinal gular folds is a non-environmentally induced autapomorphy for this genus and constitutes a presumed synapomorphy for *P. gularis* and Manthey and Nabhitabhata's (1991) new, second species *phuwuanensis.* We therefore conclude that these authors were correct in placing their new species together with *gularis* in *Ptyctolaemus* Peters, 1864. Consequently, we regard *Mantheyus* Ananjeva and Stuart, 2001 as its junior, subjective synonym.

Of course, our reinterpretation of *Mantheyus* as a junior synonym of *Ptyctolaemus* is based on existing data and future phylogenetic studies, particularly those based on molecular data, may alter this interpretation. However, at present the generic partition of these two, synapomorphically linked agamids seems unwarranted as their systematic relationships are obscured rather than elucidated by this procedure; all the more as there is so far no evidence for a long-standing historical isolation between the two. In agamids, some similar recent cases of generic partitions should be borne in mind that also proved to be short-lived.

Based on some phenetic scalation differences, Manthey and Grossmann (1997) separated the former *Cophotis sumatrana* from its Sri Lankan congener (and generotype) *Cophotis ceylanica* and placed it in a new monotypic genus *Pseudocophotis,* whereas Hallermann and Böhme (2000) could demonstrate its synapomorphic affiliation to the genus *Pseudocalotes.* In this context we want to note that the specimen of *"Pseudocalotes flavigula"* (Texas Memorial Museum TNHC 5840) used by Macey et al. (2000) in their phylogenetic analysis is in fact the holotype of *Pseudocalotes larutensis* described by Hallermann and McGuire (2001).

Ananjeva (1986) extracted *Phrynocephalus mystaceus* from its genus and resurrected the name *Megalochilus* as a monotypic accommodation, because of its remarkable (though adaptive) erectile skin flaps in the mouth angles (see point 3

at the beginning of this note). Based on a phylogeny using morphology, Arnold (1999) was able to demonstrate that *mystaceus* is clearly nested within *Phrynocephalus,* a finding which was subsequently corroborated by molecular evidence (Macey et al., 2000). Similar to this last example is the case of the Australian shingleback lizard *(Tiliqua rugosa).* Because of its aberrant body scalation, it was long placed in a monotypic genus *Trachydosaurus.* However, modern analyses (e.g., Hutchinson, 1980) have shown it to be a member of the blue-tongue skinks *(Tiliqua),* with two species of which it may even produce viable hybrid (though infertile) offspring (Shea, 1992; Ziegler and Böhme, 2000).

This last aspect, i.e., the ability to produce viable (though not fertile!) offspring, was justifiably included by Dubois (1988) in his new integrated approach to a less arbitrary notion of the genus concept. Although this criterion has, of course, very low chances of ever being tested in such rare animals as the small agamids discussed here, the erection of new, monotypic genera should be performed only with the greatest caution and reserve because otherwise the notion of the genus - as was formulated by Richter (1943), "will be invalidated as just a simple prefix of the species name" (our translation).

LITERATURE CITED

ANANJEVA, N. B. 1986. O rodovoj samostoyatelnosti ushastoj kriglogolovki, *Megalochilus mystaceus* (Pallas, 1776) [On the validity of *Megalochilus mystaceus* (Pallas, 1776)]. *Trud. Zool. Inst. AN SSSR, Leningrad* 157: 4-13. (In Russian, with English summary.)

________& B. L. STUART. 2001. The agamid lizard *Ptyctolaemus phuwuanensis* Manthey and Nabhitabhata, 1991 from Thailand and Laos represents a new genus. *Russian J. Herpetol.* 8(3): 165-170.

ARNOLD, E. N. 1999. Phylogenetic relationships of toad-headed lizards (*Phrynocephalus*, Agamidae) based on morphology. *Bull. nat. Hist. Mus. London (Zool.).* 65(1): 1-13.

DUBOIS, A. 1988. The genus in zoology: a contribution to the theory of evolutionary systematics. *Mem. Mus. Nat. Hist. nat., Paris, (Zool.).* 140: 1-122.

HALLERMANN, J. & W. BÖHME. 2000. A review of the genus *Pseudocalotes* (Squamata: Agamidae), with description of a new species from West Malaysia. *Amphibia-Reptilia* 21(2): 193-210.

________& J. A. McGUIRE. 2001. A new species of *Pseudocalotes* from Bukit Larut, West Malaysia. *Herpetologica* 57(3): 255-265.

HENNIG, W. 1950. Theorie der Grundlagen einer phylogenetischen Systematik. Deutscher Zentralverlag, Berlin. 370 pp.

________.1966. Phylogenetic systematics. University of Illinois Press, Urbana. xv + 439 pp.

HONDA, M., H. OTA, M. KOBAYASHI, J. NABHITABHATA, H.-S. YONG, S. SENGOKU & T. HIKIDA. 2000a. Phylogenetic relationships of the family Agamidae (Reptilia: Iguania) inferred from mitochondrial DNA sequences. *Zool. Sci.* 17: 527-537.

________,________ , S. SENGOKU & T. HIKIDA. 2000b. Phylogenetic position of *Draco fimbriatus*, with a molecular perspective on the historical biogeography of the genus *Draco* (Reptilia: Agamidae). *Current Herpetol.* 19(2): 43-55.

________,________,________ , H.-S. YONG & T. HIKIDA. 2002. Molecular evaluation of phylogenetic significances in the highly divergent karyotypes of the genus *Gonocephalus* (Reptilia: Agamidae) from tropical Asia. *Zool. Sci*. 19(1): 129-133.

HUTCHINSON, M. N. 1980. The systematic relationships of the genera *Egernia* and *Tiliqua* (Lacertilia: Scincidae). A review and immunological reassessment. *In:* Proceedings of the Melbourne Herptological Symposium. pp: 176-193. C. B. Banks & A. A. Martin (Eds). Melbourne.

MACEY, J. R., J. A. SCHULTE, II, A. LARSON, N. B. ANANJEVA, Y. WANG, R. PETHIYAGODA & N. RASTEGAR-POUYANI. 2000. Evaluating trans-Tethys migration: an example using acrodont lizard phylogenetics. *Syst. Biol.* 49 (2): 233-256.

MANTHEY, U. & W. GROSSMANN. 1997. Amphibien & Reptilien Südostasiens. Natur und Tier-Verlag, Münster. 512 pp.

________ & J. NABHITABHATA. 1991. Eine neue Agame, *Ptyctolaemus phuwuanensis* sp. n. (Sauria: Agamidae), aus Nordost-Thailand. *Sauria, Berlin* 13(4): 3-6. [English edition: An Agamid lizard, *Ptychtolaemus phuwuanensis* Manthey and Nabhitabhata 1991 (Sauria: Agamidae) from Northeast-Thailand. *Sauria, Kempton Park* 1(2): 3-6.]

MOODY, S. M. 1980. Phylogenetic and historical biogeographical relationships of the genera in the family Agamidae (Reptilia: Lacertilia). Unpublished Ph.D. Thesis, Univ. of Michigan, Ann Arbor. 373 pp.

RICHTER, R. 1943. Einführung in die Zoologische Nomenklatur durch Erläuterung der Internationalen Regeln. Senckenbergische Naturforschende Gesellschaft, Frankfurt am Main. 154 pp.

SHEA, G. M. 1992. The systematics and reproduction of bluetongue lizards of the genus *Tiliqua* (Squamata: Scincidae). Ph.D. Thesis, Univ. of Sydney, Sydney. Four vols.

ZIEGLER, T. & W. BÖHME. 2000. Zur Genitalmorphologie der Blauzungenskinke (Scincidae: Lygosominae: *Tiliqua*). *In*: Blauzungenskinke, Beiträg zu *Tiliqua* und *Cyclodomorphus*. pp: 45-52. A. Hauschild, R. Hitz, K. Henle, G. M. Shea & H. Werning (Eds). Natur und Tier-Verlag, Münster.

Jakob Hallermann[1] and Wolfgang Böhme[2],
[1]Zoologisches Institut und Zoologisches Museum, University of Hamburg, Martin-Luther-King-Platz 3, 20146 Hamburg, Germany. Email: hallermann@zoologie.uni-hamburg.de.
[2]Zoologisches Forschungsinstitut und Museum Alexander Koenig, Adenauerallee 160, 53113 Bonn, Germany. Email: w.boehme.zfmk@uni-bonn.de.

Received: 24 September 2002.
Accepted: 21 January 2003.

Hamadryad Vol. 27, No. 2, pp. 265 – 266, 2003

Unusual foraging behaviour of *Naja kaouthia* at the Moyingye Wetlands Bird Sanctuary, Myanmar

The monocled cobra, *Naja kaouthia* and the banded krait, *Bungarus fasciatus* are common residents of Myanmar's paddies. Neither species has had a detailed examination of its diet in Myanmar or elsewhere in southern and south-eastern Asia. In general reports (e.g., Cox et al., 1998), *N. kaouthia* eats frogs, snakes, small birds and mammals; *B. fasciatus* eats lizards, snakes and small mammals. Our experiences suggest that *N. kaouthia* is mainly crepuscular and *B. fasciatus* is strictly nocturnal.

The above dietary information applies generally to the krait and cobra at the Moyingye Wetland Bird Sanctuary (17° 35.305'N; 96° 34.735'E; Bago Division, Myanmar); however, one of us (SWK) has occasionally seen the occurrence of both species in fish traps. The Moyingye W. B. S. was created by the damming of three streams (Pyin Bon Gyi, Win Be Inn, Payakalay) flowing into the Waw River. The damming expanded the original wild rice marsh and created a large, moderately shallow permanent lake. Nearly all of the 104 km^2 of the sanctuary are flooded during the height of the monsoon; during the height of the dry season, only the lake and the immediately bordering marshes and paddies contain water, approximately a quarter of the monsoonal wetland area. At all times, the waters of the Sanctuary are heavily fished with line nets and fish traps.

Two fishing methods capture snakes as well as fish. The line nets capture *Enhydris enhydris*, *Homalopsis buccata*, *Ptyas mucosus* and *N. kaouthia*. The latter two are rarely drowned owing to their entanglement on the surface, having been entangled in the net as they crossed open water. The fish traps capture *H. buccata*, *B. fasciatus* and *N. kaouthia*. In 2002, SWK saw three fish traps, each containing a krait, and two traps each with a cobra. Both cobras contained one or more fish in their stomachs; neither krait contained fish. Although abundant, *Xenochrophis piscator* is not seen in the traps.

MANTHEY, U. & W. GROSSMANN. 1997. Amphibien & Reptilien Südostasiens. Natur und Tier-Verlag, Münster. 512 pp.

________& J. NABHITABHATA. 1991. Eine neue Agame, *Ptyctolaemus phuwuanensis* sp. n. (Sauria: Agamidae), aus Nordost-Thailand. *Sauria, Berlin* 13(4): 3-6. [English edition: An Agamid lizard, *Ptychtolaemus phuwuanensis* Manthey and Nabhitabhata 1991 (Sauria: Agamidae) from Northeast-Thailand. *Sauria, Kempton Park* 1(2): 3-6.]

MOODY, S. M. 1980. Phylogenetic and historical biogeographical relationships of the genera in the family Agamidae (Reptilia: Lacertilia). Unpublished Ph.D. Thesis, Univ. of Michigan, Ann Arbor. 373 pp.

RICHTER, R. 1943. Einführung in die Zoologische Nomenklatur durch Erläuterung der Internationalen Regeln. Senckenbergische Naturforschende Gesellschaft, Frankfurt am Main. 154 pp.

SHEA, G. M. 1992. The systematics and reproduction of bluetongue lizards of the genus *Tiliqua* (Squamata: Scincidae). Ph.D. Thesis, Univ. of Sydney, Sydney. Four vols.

ZIEGLER, T. & W. BÖHME. 2000. Zur Genitalmorphologie der Blauzungenskinke (Scincidae: Lygosominae: *Tiliqua*). *In*: Blauzungenskinke, Beiträg zu *Tiliqua* und *Cyclodomorphus*. pp: 45-52. A. Hauschild, R. Hitz, K. Henle, G. M. Shea & H. Werning (Eds). Natur und Tier-Verlag, Münster.

Jakob Hallermann[1] and Wolfgang Böhme[2],
[1]Zoologisches Institut und Zoologisches Museum, University of Hamburg, Martin-Luther-King-Platz 3, 20146 Hamburg, Germany. Email: hallermann@zoologie.uni-hamburg.de.
[2]Zoologisches Forschungsinstitut und Museum Alexander Koenig, Adenauerallee 160, 53113 Bonn, Germany. Email: w.boehme.zfmk@uni-bonn.de.

Received: 24 September 2002.
Accepted: 21 January 2003.

Hamadryad Vol. 27, No. 2, pp. 265 – 266, 2003

Unusual foraging behaviour of *Naja kaouthia* at the Moyingye Wetlands Bird Sanctuary, Myanmar

The monocled cobra, *Naja kaouthia* and the banded krait, *Bungarus fasciatus* are common residents of Myanmar's paddies. Neither species has had a detailed examination of its diet in Myanmar or elsewhere in southern and south-eastern Asia. In general reports (e.g., Cox et al., 1998), *N. kaouthia* eats frogs, snakes, small birds and mammals; *B. fasciatus* eats lizards, snakes and small mammals. Our experiences suggest that *N. kaouthia* is mainly crepuscular and *B. fasciatus* is strictly nocturnal.

The above dietary information applies generally to the krait and cobra at the Moyingye Wetland Bird Sanctuary (17° 35.305'N; 96° 34.735'E; Bago Division, Myanmar); however, one of us (SWK) has occasionally seen the occurrence of both species in fish traps. The Moyingye W. B. S. was created by the damming of three streams (Pyin Bon Gyi, Win Be Inn, Payakalay) flowing into the Waw River. The damming expanded the original wild rice marsh and created a large, moderately shallow permanent lake. Nearly all of the 104 km^2 of the sanctuary are flooded during the height of the monsoon; during the height of the dry season, only the lake and the immediately bordering marshes and paddies contain water, approximately a quarter of the monsoonal wetland area. At all times, the waters of the Sanctuary are heavily fished with line nets and fish traps.

Two fishing methods capture snakes as well as fish. The line nets capture *Enhydris enhydris*, *Homalopsis buccata*, *Ptyas mucosus* and *N. kaouthia*. The latter two are rarely drowned owing to their entanglement on the surface, having been entangled in the net as they crossed open water. The fish traps capture *H. buccata*, *B. fasciatus* and *N. kaouthia*. In 2002, SWK saw three fish traps, each containing a krait, and two traps each with a cobra. Both cobras contained one or more fish in their stomachs; neither krait contained fish. Although abundant, *Xenochrophis piscator* is not seen in the traps.

These observations suggest that the cobras intentionally entered the traps to catch the trapped fish. The kraits trap entry is less easily explained. The fish traps are not placed abutting the banks of the paddies, although they are not distant, ranging roughly from 10 to 50 cm from the water's edge. Traps are placed to allow the top of the trap to be at the water's surface or projecting slightly above. Kraits regularly forage at the water edge, and possibly with rice stubble or aquatic vegetation forming a flexible substrate, they venture out on the water and are intercepted accidentally by the traps.

Fishes are not considered a major dietary item for Asian cobras; however, fishes have been noted in the diet of some species. Only Das in his recent fieldguide (2002) lists fish as an occasional food item for *N. kaouthia* and *N. naja* in India. No other reports of Asian cobra eating fish have been discovered in our literature search. Three African cobras are reported as occasional fish eaters: *Naja melanoleuca* (Luiselli et al., 1997); *Naja nigricollis* (Luiselli et al., 1997); *Pseudohaje goldii* (Pauwels et al., 1999). The observations at the Moyingye W. B. S. suggest that fish traps with several struggling fish create an enticing lure to a cobra on the prowl for food. Is this behaviour peculiar to Moyingye or does it occur elsewhere in Myanmar and southern/south-eastern Asia? We shall attempt to obtain this information from other comparable paddy-lake areas in Myanmar.

Field work at Moyingye is part of the Myanmar Herpetological Survey, a joint biodiversity survey project of the Nature and Wildlife Conservation Division (Myanmar), California Academy of Sciences, and Smithsonian Institution, sponsored by the USA National Science Foundation DEB 9971861. Field work in February 2003 and subsequent survey and monitoring studies by SWK and GRZ also received support from Harold A. Dundee. We thank H. A. Dundee and J. Vindum for reviewing early drafts of this report, and P. David and V. Wallach for comments on a later version.

LITERATURED CITED

COX, M., P. P. VAN DIJK, J. NABHITABHATA & K. THIRAHUPT. 1998. A photographic guide to snakes and other reptiles of Peninsular Malaysia, Singapore and Thailand. Ralph Curtis Books, Sanibel Island, Florida. 144 pp.

DAS, I. 2002. A photographic guide to the snakes and other reptiles of India. New Holland Publishers (U.K.) Ltd., London. 144 pp.

LUISELLI, L., L. BIKIKORO & L. CHIYERE-UDE. 1997. Fish-eating by the cobras *Naja melanoleuca* and *Naja nigricollis* (Elapidae) in the Niger Delta (Port Harcourt, Rivers State, Nigeria). *British Herpetol. Soc. Bull*. 59: 13-14.

PAUWELS, O. S. G., P. DAVID & G. LENGELT. 1999. *Pseudohaje goldii* (Boulenger, 1895); Goldie's tree cobra: diet. *African Herp News* 30: 32-33.

Sai Wunna Kyi[1] and George R. Zug[2]
[1]Nature and Wildlife Conservation Division, Forestry Department, Insein, Yangon, Myanmar; [2]Division of Amphibians and Reptiles, National Museum of Natural History, Smithsonian Institution, P.O. Box 37012, Washington, D.C., 20013-7012, USA;
Email: zug.george@nmnh.si.edu

Received: 26 March 2003.
Accepted: 8 April 2003.

Hamadryad Vol. 27, No. 2, pp. 266 – 268, 2003

Noteworthy prey item records of two snakes (*Chrysopelea ornata* and *Macropisthodon flaviceps*) from Peninsular Malaysia

While examining the herpetological collection of the Department of Wildlife and National Parks (Peninsular Malaysia) (DWNP) in Cheras, Selangor, Peninsular Malaysia, the stomach contents of two colubrid snakes were uncovered upon dissection. A microchiropteran bat was found from a *Chrysopelea ornata* (Shaw), while a large adult toad was found in each of two

These observations suggest that the cobras intentionally entered the traps to catch the trapped fish. The kraits trap entry is less easily explained. The fish traps are not placed abutting the banks of the paddies, although they are not distant, ranging roughly from 10 to 50 cm from the water's edge. Traps are placed to allow the top of the trap to be at the water's surface or projecting slightly above. Kraits regularly forage at the water edge, and possibly with rice stubble or aquatic vegetation forming a flexible substrate, they venture out on the water and are intercepted accidentally by the traps.

Fishes are not considered a major dietary item for Asian cobras; however, fishes have been noted in the diet of some species. Only Das in his recent fieldguide (2002) lists fish as an occasional food item for *N. kaouthia* and *N. naja* in India. No other reports of Asian cobra eating fish have been discovered in our literature search. Three African cobras are reported as occasional fish eaters: *Naja melanoleuca* (Luiselli et al., 1997); *Naja nigricollis* (Luiselli et al., 1997); *Pseudohaje goldii* (Pauwels et al., 1999). The observations at the Moyingye W. B. S. suggest that fish traps with several struggling fish create an enticing lure to a cobra on the prowl for food. Is this behaviour peculiar to Moyingye or does it occur elsewhere in Myanmar and southern/south-eastern Asia? We shall attempt to obtain this information from other comparable paddy-lake areas in Myanmar.

Field work at Moyingye is part of the Myanmar Herpetological Survey, a joint biodiversity survey project of the Nature and Wildlife Conservation Division (Myanmar), California Academy of Sciences, and Smithsonian Institution, sponsored by the USA National Science Foundation DEB 9971861. Field work in February 2003 and subsequent survey and monitoring studies by SWK and GRZ also received support from Harold A. Dundee. We thank H. A. Dundee and J. Vindum for reviewing early drafts of this report, and P. David and V. Wallach for comments on a later version.

LITERATURED CITED

COX, M., P. P. VAN DIJK, J. NABHITABHATA & K. THIRAHUPT. 1998. A photographic guide to snakes and other reptiles of Peninsular Malaysia, Singapore and Thailand. Ralph Curtis Books, Sanibel Island, Florida. 144 pp.

DAS, I. 2002. A photographic guide to the snakes and other reptiles of India. New Holland Publishers (U.K.) Ltd., London. 144 pp.

LUISELLI, L., L. BIKIKORO & L. CHIYERE-UDE. 1997. Fish-eating by the cobras *Naja melanoleuca* and *Naja nigricollis* (Elapidae) in the Niger Delta (Port Harcourt, Rivers State, Nigeria). *British Herpetol. Soc. Bull*. 59: 13-14.

PAUWELS, O. S. G., P. DAVID & G. LENGELT. 1999. *Pseudohaje goldii* (Boulenger, 1895); Goldie's tree cobra: diet. *African Herp News* 30: 32-33.

Sai Wunna Kyi[1] and George R. Zug[2]
[1]Nature and Wildlife Conservation Division, Forestry Department, Insein, Yangon, Myanmar; [2]Division of Amphibians and Reptiles, National Museum of Natural History, Smithsonian Institution, P.O. Box 37012, Washington, D.C., 20013-7012, USA;
Email: zug.george@nmnh.si.edu

Received: 26 March 2003.
Accepted: 8 April 2003.

Hamadryad Vol. 27, No. 2, pp. 266 – 268, 2003

Noteworthy prey item records of two snakes (*Chrysopelea ornata* and *Macropisthodon flaviceps*) from Peninsular Malaysia

While examining the herpetological collection of the Department of Wildlife and National Parks (Peninsular Malaysia) (DWNP) in Cheras, Selangor, Peninsular Malaysia, the stomach contents of two colubrid snakes were uncovered upon dissection. A microchiropteran bat was found from a *Chrysopelea ornata* (Shaw), while a large adult toad was found in each of two

Macropisthodon flaviceps (Duméril, Bibron and Duméril).

There are only a few accounts of bats (Order Chiroptera) included in the natural diets of snakes in south-east Asia. The single most striking example is the cave racer, *Elaphe taeniura ridleyi*, which appears to be feeding regularly on cave-dwelling bats (Tweedie, 1983; Stuebing and Inger, 1999). However, this subspecies does not feed exclusively on bats, and only does so when inhabiting caves. Outside of caves, it has been found in forests and close to villages, where it might feed on rats (Schulz, 1996). Other snakes which have been reported to feed on bats most certainly do so opportunistically, while taking other prey items including birds, frogs and lizards. Such species include *Gonyosoma oxycephalum* and *Chrysopelea paradisi*, although no specific prey identity or data was provided (Cox et al., 1998).

At DWNP, an adult male *Chrysopelea ornata* (field # DWNP-K010: SVL 86.5 cm; tail 29.3 cm) was found with a significantly distended stomach, with the bulge situated 35 cm from the head. The specimen had been collected by staff of the DWNP at Kuala Gula, Perak, within an office compound, on 16 January 1993. When dissected, the prey was found to be a freshly ingested male black-bearded tomb bat, *Taphozus melanopogon* Temminck, with intact fur and little sign of digestion. Measurements of the prey item were taken using a slide vernier: head-body 74.4 mm, ear 13.6 mm, forearm 67.1 mm, tibia 25.1 mm, tail 21.8 mm. Its wet weight (obtained using electronic balance) was 22.1 g. This is the first record of a bat being taken prey by this snake species. As *C. ornata* is strictly diurnal, it would presumably either have foraged for the roosting bats, or found an injured/disabled individual.

Outside of south-east Asia, bats have also been known to fall prey to various snakes, such as *Liasis childreni* in Australia and *Trimorphodon biscutatus* in Mexico (Mattison, 1995). In Tamil Nadu, southern India, *Python molurus* was recorded to feed on the Indian flying fox, *Pteropus giganteus*, as observed by Foster and Price (1997), who also reviewed snake predation on bats. The boid *Epicrates angulifer* frequently preys upon several species of bats in Cuba (Schwartz and Henderson, 1991). In Europe, *Coluber viridiflavus* will readily accept bats whenever the opportunity arises (P. David, unpublished).

Toads in the genus *Bufo* Laurenti are characterised by their prominent paratoid glands, which are notorious for the ability to secrete noxious (sometimes poisonous) substances when harassed by potential predators. In Borneo, the larger toads (possibly *Bufo asper* and/or *B. juxtasper*) have been recorded to fall prey to *Macropisthodon flaviceps*, which otherwise feeds largely on frogs (Stuebing and Inger, 1999). This unusual choice of bufonid prey by the same species of snake is here reported for the first time from Peninsular Malaysia, supported by two voucher specimens deposited at DWNP. This implies that *B. asper*, a common riverine toad in Borneo and Peninsular Malaysia, may constitute a potentially significant component of its regular diet.

Both individuals were adult females, collected by Abdul Nasir et al. (DWNP staff) from Sungai Lallang, Ampangan, Ulu Langat, Selangor on 15 October 2002. The first snake (field # ASL 0012: total length: 93.5 cm; tail: 16.8 cm) displayed a bulge 35 cm from snout tip. Its prey was an adult male *Bufo asper* (SVL 10.2 cm), already partially digested. The second snake (field # ASL 0013: total length: 91.6 cm; tail: 18.1 cm) displayed a bulge 28 cm from snout tip. Its prey was also an adult male *B. asper* (SVL 11.0 cm), hind limbs already digested. In both cases, the heads of the toad prey were facing the anterior, indicating that they were ingested vent first. Apart from *B. asper*, other anurans encountered along this stream included *Amolops larutensis*, *Rana hosii*, *Rana signata* and *Phrynella pulchra* (vouchers deposited at DWNP).

Outside of the Sunda region, large toads have known to be preyed upon by a host of snakes, with and without fatal consequences. In Australia, for example, the introduced *Bufo marinus* has been ingested by various native snakes (*Stegonotus cucullatus*, *Boiga irregularis*,

Pseudechis porphyriacus, *P. papuanus*, *Pseudonaja textilis*, *Notechis scutatus*), resulting in their deaths. However, other snakes (*Leptodeira annulata*, *Tropidonophis mairii*, *Dendrelaphis puntulatus*) have consumed this toad without any ill effects (Tyler, 1994).

We thank Abdul Nasir and his accompanying field staff for their significant contributions to the DWNP herpetological collection; Kelvin K. P. Lim for his kind assistance with the measurements and documentation of the specimens; two anonymous reviewers for enlightening suggestions and helpful comments.

LITERATURE CITED

COX, M. J., P. P. VAN DIJK, J. NABHITABHATA & K. THIRAKUPT. 1998. A photographic guide to snakes and other reptiles of Peninsular Malaysia, Singapore and Thailand. New Holland, London. 144 pp.

FOSTER, J. & P. PRICE. 1997. A case of predation by *Python molurus* on a fruit bat, *Pteropus giganteus*, with notes on bat-snake interactions. *Hamadryad* 22(1): 58-61.

MATTISON, C. 1995. The encyclopedia of snakes. Facts on File Inc., New York. 256 pp.

SCHULZ, K.-D. 1996. A monograph of the colubrid snakes of the genus *Elaphe* Fitzinger. Koeltz Scientific Books, Havlickuv Brod. iii + 439 pp.; 58 pl.

SCHWARTZ, A. & R. W. HENDERSON. 1991. Amphibians and reptiles of the West Indies: descriptions, distribution, and natural history. University Press of Florida, Gainesville. xvi + 720 pp.

STUEBING, R. B. & R. F. INGER. 1999. A field guide to the snakes of Borneo. Natural History Publications (Borneo), Kota Kinabalu. v + 254 pp.

TWEEDIE, M. W. F. 1983. The snakes of Malaya. Third edition. Singapore National Printers, Singapore. 167 pp.

TYLER, M. J. 1994. Australian frogs: a natural history. Reed Books, Chatswood, New South Wales. 192 pp.

Tzi Ming Leong[1] and Boo Liat Lim[2]
[1]Department of Biological Sciences, National University of Singapore, Kent Ridge, Singapore 119260.
Email: scip0132@nus.edu.sg
[2]Department of Wildlife and National Parks, Km 10, Jalan Cheras, 50664, Kuala Lumpur, Malaysia.

Received: 5 December 2002.
Accepted: 30 December 2002.

Hamadryad Vol. 27, No. 2, pp. 268 – 270, 2003

Noteworthy dietary records for *Caudacaecilia larutensis* and *Limnonectes kuhlii* from Maxwell's Hill, Peninsular Malaysia (Amphibia: Gymnophiona and Anura)

(with three text-figures)

During a brief excursion to Maxwell's Hill (Bukit Larut; 05° 00'N; 100° 53'E), Perak, Peninsular Malaysia, the topotypic caecilian *Caudacaecilia larutensis* (Taylor, 1960) and a ranid frog *Limnonectes kuhlii* (Tschudi, 1838) were encountered, whose gut contents were removed, identified and reported here. Although isolated accounts of diet are often of limited value, they are nevertheless presented due to the lack of knowledge of the ecology of the taxa under study. For caecilians especially, little is known about their diets (O'Reilly, 2000).

Both amphibians were encountered at the upper elevations of Maxwell's Hill (> 1,000 m asl) by the sides of the main road (flanked by montane forest) leading to the telecommunications station at the summit (1,448 m asl). The caecilian *Caudacaecilia*

Pseudechis porphyriacus, *P. papuanus*, *Pseudonaja textilis*, *Notechis scutatus*), resulting in their deaths. However, other snakes (*Leptodeira annulata*, *Tropidonophis mairii*, *Dendrelaphis puntulatus*) have consumed this toad without any ill effects (Tyler, 1994).

We thank Abdul Nasir and his accompanying field staff for their significant contributions to the DWNP herpetological collection; Kelvin K. P. Lim for his kind assistance with the measurements and documentation of the specimens; two anonymous reviewers for enlightening suggestions and helpful comments.

LITERATURE CITED

COX, M. J., P. P. VAN DIJK, J. NABHITABHATA & K. THIRAKUPT. 1998. A photographic guide to snakes and other reptiles of Peninsular Malaysia, Singapore and Thailand. New Holland, London. 144 pp.

FOSTER, J. & P. PRICE. 1997. A case of predation by *Python molurus* on a fruit bat, *Pteropus giganteus*, with notes on bat-snake interactions. *Hamadryad* 22(1): 58-61.

MATTISON, C. 1995. The encyclopedia of snakes. Facts on File Inc., New York. 256 pp.

SCHULZ, K.-D. 1996. A monograph of the colubrid snakes of the genus *Elaphe* Fitzinger. Koeltz Scientific Books, Havlickuv Brod. iii + 439 pp.; 58 pl.

SCHWARTZ, A. & R. W. HENDERSON. 1991. Amphibians and reptiles of the West Indies: descriptions, distribution, and natural history. University Press of Florida, Gainesville. xvi + 720 pp.

STUEBING, R. B. & R. F. INGER. 1999. A field guide to the snakes of Borneo. Natural History Publications (Borneo), Kota Kinabalu. v + 254 pp.

TWEEDIE, M. W. F. 1983. The snakes of Malaya. Third edition. Singapore National Printers, Singapore. 167 pp.

TYLER, M. J. 1994. Australian frogs: a natural history. Reed Books, Chatswood, New South Wales. 192 pp.

Tzi Ming Leong[1] and Boo Liat Lim[2]
[1]Department of Biological Sciences, National University of Singapore, Kent Ridge, Singapore 119260.
Email: scip0132@nus.edu.sg
[2]Department of Wildlife and National Parks, Km 10, Jalan Cheras, 50664, Kuala Lumpur, Malaysia.

Received: 5 December 2002.
Accepted: 30 December 2002.

Hamadryad Vol. 27, No. 2, pp. 268 – 270, 2003

Noteworthy dietary records for *Caudacaecilia larutensis* and *Limnonectes kuhlii* from Maxwell's Hill, Peninsular Malaysia (Amphibia: Gymnophiona and Anura)

(with three text-figures)

During a brief excursion to Maxwell's Hill (Bukit Larut; 05° 00'N; 100° 53'E), Perak, Peninsular Malaysia, the topotypic caecilian *Caudacaecilia larutensis* (Taylor, 1960) and a ranid frog *Limnonectes kuhlii* (Tschudi, 1838) were encountered, whose gut contents were removed, identified and reported here. Although isolated accounts of diet are often of limited value, they are nevertheless presented due to the lack of knowledge of the ecology of the taxa under study. For caecilians especially, little is known about their diets (O'Reilly, 2000).

Both amphibians were encountered at the upper elevations of Maxwell's Hill (> 1,000 m asl) by the sides of the main road (flanked by montane forest) leading to the telecommunications station at the summit (1,448 m asl). The caecilian *Caudacaecilia*

larutensis was spotted on 29 March 2003 at 0005 h, ca. 150 m downhill of the Gunong Hijau Resthouse (1,113 m asl), and observed entering its burrow, with 2/3 of its body already inside. Prior to preservation, photographs of the live specimen were taken (Fig. 1), and are possibly the first of this species in life (David Gower, pers. comm.). During preservation, a hard object was detected ca. 6 cm from snout tip and removed via incision to the gut, along with other softer gut contents. The frog *Limnonectes kuhlii* was encountered on the night of 27 March 2003 (ca. 2200 h) in a level roadside drainage with clear slow-flowing water, ca. 1 km uphill of the Gunong Hijau Resthouse. A hard object was also detected in the frog's belly during preservation and duly removed. Gut contents of both amphibians were preserved in 70% alcohol. Both amphibians were fixed in 10% formaldehyde, transferred to 70% alcohol and catalogued in the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research (RMBR), National University of Singapore. Total length of the caecilian was obtained with flexible measuring tape (to 0.1 cm); all other measurements were taken using slide verniers (to 0.1 mm).

Of the remnant gut contents obtained from the adult male caecilian *C. larutensis* (ZRC.1.10593; total length 30.1 cm; tail 2.8 mm), the key components were a forelimb and the antenna of an insect. Upon consultation with appropriate literature (O'Brien et al., 1991: 83; Fig. 30.12) and comparisons with relevant specimens at the entomology collection (RMBR), the prey was identified as a cicada larva (Homoptera: Cicadidae: genus and species undetermined). The specially modified forelimb, adaptations for its fossorial lifestyle, is the most diagnostic character (Fig. 2). It is uncertain whether or not such a heavily chitinised structure would be able to undergo complete digestion or be passed out intact subsequently. This find strongly suggests that its hunting/feeding mode is largely subterranean.

The frog *Limnonectes kuhlii* (Tschudi) (ZRC.1.10572; snout-vent length 64.9 mm; subadult, sex undetermined) was actually found together with two other individuals of the same species (ZRC.1.10573-10574; SVL 52.8 and

FIGURE 1: Adult male *Caudacaecilia larutensis* Taylor (1960) (ZRC.1.10593; total length 30.1 cm) in life, from type locality of Maxwell's Hill, Perak, Peninsular Malaysia.

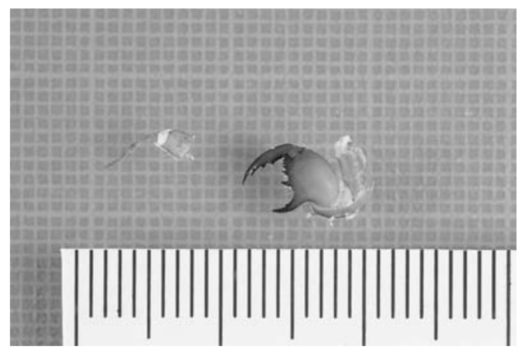

FIGURE 2: Antenna and front left fossorial forelimb of cicada larva (Homoptera: Cicadidae) recovered from adult male *Caudacaecilia larutensis* (ZRC.1.10593).

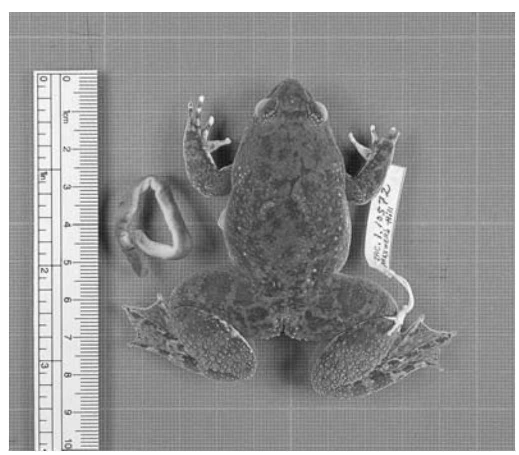

FIGURE 3: Preserved specimen of sub-adult *Limnonectes kuhlii* (ZRC.1.10572; SVL 64.9 mm) from Maxwell's Hill, with Hirudinean prey of *Gastrostomobdella vagabunda* (outstretched length 72.3 mm) pictured left of frog.

107.3 mm, respectively). When dissected, the 'hard object' that was initially detected externally for ZRC.1.10572 turned out to be the head and thorax of an adult female orthopteran (ovipositor present, body and limbs bright green when freshly removed). In addition, the gut contained a single example of a leech (Annelida: Hirudinea) *Gastrostomobdella vagabunda* Moore, 1935 (Fig. 3). This had a total length of 72.3 mm, maximum width of 5.9 mm, and displayed signs of partial digestion.

While no leeches were uncovered from the guts of the other two frogs (ZRC.1.10573, 10574) and this choice of prey may appear to be an isolated incident, the finding is an unusual one nevertheless. Although it is a generally accepted fact that frogs do play host to leeches occasionally, specific examples are scarce, especially for south-east Asia. In Singapore, the ranid *Limnonectes malesianus* (Kiew) was observed to be attacked by the swamp leech (*Hirudinaria* sp.) (Leong, 2001). But conversely, accounts of anurans preying upon leeches are even fewer and far between. Thus, this report of *L. kuhlii* feeding on the leech *G. vagabunda* suggests the possibility that, given the opportunity, other hirudineans may fall prey to anuran species which tend to be generalist/non-selective feeders. Apart from the occasional (incidental) leech prey, it has actually been well documented that in general, frogs of the family Ranidae readily consume a vast variety of animals (Inger and Marx, 1961; Inger and Greenberg, 1966).

We are grateful to Lim Boo Liat (Department of Wildlife and National Parks, Perhilitan) for his continual encouragements and support of natural history research in Malaysia. The warm hospitality and culinary skills of T. Guna were very much appreciated during our brief stay at the Gunong Hijau resthouse. H. K. Lua (Raffles Museum of Biodiversity Research) offered her kind and enthusiastic assistance with the identification of the stomach contents and granted access to reference material. Robert Inger (Field Museum of Natural History, Chicago) and David Gower (The Natural History Museum, London) kindly reviewed the manuscript and contributed with constructive comments.

LITERATURE CITED

INGER, R. F. & H. MARX. 1961. The food of amphibians. *Explor. Parc natn. Upemba Miss. G. F. de Witte* 64: 1-86.

________ & B. GREENBERG. 1966. Ecological and competitive relations among three species of frogs (genus *Rana*). *Ecology* 47(5): 746-759.

LEONG, T.-M. 2001. Natural history notes: *Limnonectes malesianus*- Ectoparasite. *Herpetol. Rev*. 32(2): 103.

MOORE, J. P. 1935. Leeches from Borneo and the Malay Peninsula. *Bull. Raffles Mus.* 10: 67-79, pls. VI, VII.

O'BRIEN, L. B., M. B. STOETZEL & D. R. MILLER. 1991. Order Homoptera. *In*: Immature insects, Volume 2. pp: 66-111. F. W. Stehr (Ed). Kendall/Hunt Publishing Company, Iowa.

O'REILLY, J. C. 2000. Feeding in caecilians. *In*: Feeding: form, function, and evolution in tetrapod vertebrates. pp: 149-166. K. Schwenk. (Ed). Academic Press, San Diego.

PRESSWELL, B., D. J. GOWER, O. V. OOMEN, G. J. MEASEY & M. WILKINSON. 2002. Scolecophidian snakes in the diets of south Asian caecilians (Amphibia: Gymnophiona). *Herpetol. J.* 12: 123-126.

TAYLOR, E. H. 1960. On the caecilian species *Ichthyophis monochrous* and *Ichthyophis glutinosus*, with descriptions of related species. *Univ. Kansas Sci. Bull.* 40(4): 37-120.

Tzi-Ming Leong[1] and Gary Hock-Sheong Lim[2]
[1]Systematics & Ecology Lab, Department of Biological Sciences, National University of Singapore, Kent Ridge, Singapore 119260;
Email: scip0132@nus.edu.sg
[2]The Malaysian Nature Society, JKR 641, Bukit Persekutuan, Jalan Kelantan, 50480 Kuala Lumpur, Malaysia.

Received: 12 June 2003.
Accepted: 29 June 2003.

Hamadryad Vol. 27, No. 2, pp. 271 – 273, 2003

Leptopelis notatus (Anura: Hyperoliidae) in the Massif du Chaillu, Gabon: from ethnic wars to soccer

Despite the zoogeographical importance of the Massif du Chaillu, southern central Gabon, as a possible forest refuge during the Pleistocene, its herpetofauna was virtually unknown until recently. Our recent herpetological investigations in the Massif allowed us not only to gather a preliminary list of reptile taxa, including several new records for the country (Bauer and Pauwels, 2002; Pauwels et al., 2002a), but also uncovered important interactions between the local ethnic groups and several snake species (Pauwels et al., 2002b). We here report ethnozoological data on amphibians gathered during our three visits to the village of Diyanga (01° 30' 56''S - 11° 43' 45''E; altitude 565 m asl, Ogoulou Department, Ngounié Province) in July, September and November 2001. Collecting was undertaken with the help of the villagers. The village of Diyanga comprises two separated parts, inhabited by Massango Bantu and Babongo Pygmies, respectively. These two ethnic groups live in harmony, and one of us (OSGP) had the opportunity to spend many evenings recording ethnozoological notes on numerous amphibian species from elders of both ethnic groups. Notably, we recorded interesting data on a large green *Leptopelis* arboreal frog, called mobénda by the Babongo and dibougougou by the Massango, that we identified as *L. notatus* (Buchholz and Peters, 1875). It is a locally common species that occurs from western Cameroun to R. D. Congo (Frétey and Blanc, 2000; Schiøtz, 1999). Specimens were shown alive or freshly dead to the medicine man, the village elders, and hunters. Only consensual ethnozoological data and vernacular names were retained. Three voucher specimens of *Leptopelis notatus* were collected in Diyanga, deposited in the collections of the Institut Royal des Sciences naturelles de Belgique (IRSNB 13361-2 [respective field numbers, P561 and P613]) and, provisionally, in the collection of M-OR (field number P614).

In Diyanga, *Leptopelis notatus* was found in forest clearings, in secondary forest and cultivated fields. It was most often found sitting on large leaves, and did not try to escape when caught, even at night. Ten species of *Leptopelis* are known to occur in Gabon (Frétey and Blanc, 2000), among them several are found in the area of Diyanga. However, only *L. notatus* was the object of the following traditional belief and use. When our first specimens were encountered, the hunters informed us that the species is of magical importance. We therefore decided to interview as many inhabitants as possible on this species, and organized two evenings with the elders dedicated to discussions about the importance of the frogs. Magic secrets are the property of traditional medicine men (locally called "charlatans" in Gabonese French), and only they and the elders are allowed to divulge these secrets.

Only this frog species, we were told, is used to increase the performance of goalkeepers. The day before an important soccer match, the medicine man collects a specimen, preferably a large adult, stuns it, puts it in the fire and then picks up its ashes. The ashes are then stored in a banana leaf. He makes several incisions on the upper part of the wrist of the goalkeeper, and then sprinkles the ashes on the fresh wounds. We were told that this tradition is several centuries old. Given that soccer surely has not been played this long in Africa, the elders explained that soccer is just a modern form of war between ethnic groups, and that in former times, the same magic was used for the best spear throwers (spears being called dikongò and dikongó in Massango and Babongo, respectively). The best throwers were those who were able to catch the spears thrown by the enemies before they touched the ground, and to re-use them straight away. They were the best because they were vaccinated with the frog's ash the day before every battle. This magic secret is today the property of the Massangos and Babongos, and can be shared with soccer teams belonging to the same ethnic groups (like the Mimongo team), but we were asked not to divulge it to other Gabonese ethnic groups. The

name of Diyanga's soccer team is M'bia. "The vaccinated person works with the arms of this frog, his hands being also sticky". That is why only the goalkeeper is vaccinated: other players do not need sticky hands or feet. In fact, we were informed that there is another species for the feet, today used for soccer players. This species, unfortunately not collected by us during our stay in Diyanga, was formerly used for the hunters who had to walk long distances. Elders told us that in former times, their enemies were the Akélé, who kidnapped Massango women, "because Akélé women were like termites: not able to make children." "One day Akélés had no more children and had to steal Massango's wives. This was the main cause of war between Massangos and Akélés, and the reason for which Massangos had to get the best spear throwers." We were shown traditional spears, which were composed of two parts: a wooden shaft (mwiri in Massango), and a metallic point adjusted on it (dikongò and dikongó refer either to the whole spear or to the metal point only). Although these deadly tribal wars are now over, Diyanga elders still prefer their youngsters not to marry Akélés. This magic utilization of *L. notatus* is localised. In the Nzebi village of Itsiba (01° 46' 55''S - 11° 58' 41''E; altitude 670 m asl; Boumi-Louétsi Department, Ngounié Province), situated only 40 km SE of Diyanga, such use of *L. notatus* was totally unknown. In contrast, this frog is there called ipongolo and is looked upon as a symbol of laziness, since it was said to sleep all the time. Another Nzebi name for it is ipongolo kwam cholo (kwam = dead; cholo = to sleep). In Itsiba as well as in Diyanga, *L. notatus* and many other frog species were eaten by the villagers, and prepared "en paquet", like other amphibians and reptiles (see Pauwels et al., 2002b: 137).

Ptychadena aff. *mascareniensis* that we collected in July 2001 in puddles along the road at the western entrance of Diyanga village (vouchers P538-9, P543) were as important as *Leptopelis notatus* in the local folklore. They were called èngoto by the Babongo and mbènda by the Massango. They are said to sing continuously for several hours and move their legs while doing so, and were hence chosen for the vaccination of balafon players. Interestingly, Lawson (1999: 55) reported that the Oroko people of south-west Cameroon call *Ptychadena mascareniensis,* "mokabe", a name referring to "someone or something that can jump or skip continuously".

The use of *Leptopelis notatus* in magic certainly does not affect populations of this species, and the hunting for food consumption is rather limited. It is, however, essential to record specific ethnozoological data since they are, as much as the forest species themselves, likely to disappear because of environmental changes, i.e., when a given ethnic group in a given area is no longer in regular contact with a given species. These data are strictly part of the local culture and, although often neglected by conservationists, they constitute a strong, additional argument in favour of biodiversity conservation programs. The present case is remarkable in that, despite the fact that the original context, the competition between Massangos and other ethnic groups, has changed so much, from bloody wars to friendly soccer matches, the only stable element through time has been the constant use of a tree frog, *L. notatus.*

These observations are part of the results of surveys sponsored by WWF Ecoregion Program. We are grateful to our informants, particularly to Antoine Dingoudi, Henri and Syriaque Moulengui and Edmond Nzéngui (Diyanga). Marius Burger (University of Cape Town) helped with identification of the *Leptopelis*. OSGP thanks Chucheep (Teak) Chimsunchart (Phetchaburi) and Alexandre Pepy Boutolini (WWF-CARPO) for companionship in the field. Research and collecting permits were provided by Dieudonné Madanou Nzigou, Emile Mamfoumbi Kombila, Joseph Maroga-Mbina and Marc Mpami (Direction de la Faune et de la Chasse, Libreville). Georges Coulon and Georges Lenglet (IRSNB) provided working facilities. Aaron Bauer provided comments on the manuscript.

LITERATURE CITED

BAUER, A. M. & O. S. G. PAUWELS. 2002. A new forest-dwelling *Hemidactylus* (Squamata:

Gekkonidae) from Gabon, West Africa. *African J. Herpetol.* 51: 1-8.

FRÉTEY, T. & C. P. BLANC. 2000. Les amphibiens d'Afrique centrale. Liste faunistique. Dossiers de l'ADIE, Série Biodiversité, 2, Libreville. 39 pp.

LAWSON, D. P. 1993. The reptiles and amphibians of the Korup National Park Project, Cameroon. *Herpetol. nat. Hist.* 1(2): 27-90.

PAUWELS, O. S. G., A. KAMDEM TOHAM & C. CHIMSUNCHART. 2002a. Recherches sur l'herpétofaune du Massif du Chaillu, Gabon. *Bull. Inst. Roy. Sc. nat. Belgique, Biol*. 72: 47-57.

_____, _____ & V. MAMONEKENE. 2002b. Ethnozoology of the dibomina (Serpentes: Colubridae: *Grayia ornata*) in the Massif du Chaillu, Gabon. *Hamadryad* 27(1): 136-141.

SCHIØTZ, A. 1999. Treefrogs of Africa. Edition Chimaira, Frankfurt am Main. 350 pp.

Olivier S. G. Pauwels[1], Mark-Oliver Rödel[2] and André Kamdem Toham[3]

[1]Department of Recent Vertebrates, Institut Royal des Sciences naturelles de Belgique, Rue Vautier 29, 1000 Brussels, Belgium;
Email: osgpauwels@hotmail.com

[2]Department of Animal Ecology and Tropical Biology, Zoology III, Biocenter, Am Hubland, D-97074 Würzburg, Germany;
Email: roedel@biozentrum.uni-wuerzburg.de

[3]World Wildlife Fund, Central African Regional Program Office, B.P. 9144 Libreville, Gabon;
Email: kamdem.toham@internetgabon.com

Received: 23 June 2003.
Accepted: 7 July 2003.

Hamadryad Vol. 27, No. 2, pp. 273 – 276, 2003

A record of the Arakan forest turtle *Heosemys depressa* (Anderson, 1875) from the southern Arakan Yoma Hills, Myanmar

(with one text-figure)

The Arakan forest turtle, *Heosemys depressa* (Anderson, 1875), is endemic to Myanmar and considered one of the world's least known chelonians (Ernst and Barbour, 1989; van Dijk, 1993). From 1875, when the species was first described, to 1908 only five *H. depressa* were reported in the literature, all from Rakhine (formerly known as "Arakan") State in western Myanmar (Iverson and McCord, 1997). These specimens presumably originated from the Arakan Yoma Hills, although specific locality data are lacking (Iverson and McCord, 1997). More recently, Platt et al. (2003) collected 17 *H. depressa* from the northern Arakan Yoma Hills (Fig. 1), and other specimens of uncertain provenance have been obtained from turtle markets in Yunnan Province, China (Iverson and McCord, 1997; P. C. H. Pritchard, pers. comm.; J. Behler, pers. comm.). Herein we provide data on five additional *H. depressa* from a previously unreported locality in the southern Arakan Yoma Hills.

We obtained these specimens during November 2000 from villagers living in the Rakhine Yoma Elephant Range (RYER; 18° 00' N; 94° 40' E), a protected area encompassing 175, 644 ha in the southern Arakan Yoma Hills (Fig. 1). This region is characterized by evergreen forest (Stamp, 1924; Stamp, 1930; Terra, 1944) of poorly known floristic composition (Salter, 1983) and extensive tracts of bamboo (*Melocanna bambusoides*) that developed as a result of long-term shifting cultivation and frequent anthropogenic fires (Soderstrom and Calderón, 1979).

We salvaged the carapaces (without plastrons) of four adults and the complete shell of an immature *H. depressa* that were captured locally and consumed by villagers (Table 1). These specimens are currently housed in the natural his-

Gekkonidae) from Gabon, West Africa. *African J. Herpetol.* 51: 1-8.

FRÉTEY, T. & C. P. BLANC. 2000. Les amphibiens d'Afrique centrale. Liste faunistique. Dossiers de l'ADIE, Série Biodiversité, 2, Libreville. 39 pp.

LAWSON, D. P. 1993. The reptiles and amphibians of the Korup National Park Project, Cameroon. *Herpetol. nat. Hist.* 1(2): 27-90.

PAUWELS, O. S. G., A. KAMDEM TOHAM & C. CHIMSUNCHART. 2002a. Recherches sur l'herpétofaune du Massif du Chaillu, Gabon. *Bull. Inst. Roy. Sc. nat. Belgique, Biol*. 72: 47-57.

_____, _____ & V. MAMONEKENE. 2002b. Ethnozoology of the dibomina (Serpentes: Colubridae: *Grayia ornata*) in the Massif du Chaillu, Gabon. *Hamadryad* 27(1): 136-141.

SCHIØTZ, A. 1999. Treefrogs of Africa. Edition Chimaira, Frankfurt am Main. 350 pp.

Olivier S. G. Pauwels[1], Mark-Oliver Rödel[2] and André Kamdem Toham[3]
[1]Department of Recent Vertebrates, Institut Royal des Sciences naturelles de Belgique, Rue Vautier 29, 1000 Brussels, Belgium;
Email: osgpauwels@hotmail.com
[2]Department of Animal Ecology and Tropical Biology, Zoology III, Biocenter, Am Hubland, D-97074 Würzburg, Germany;
Email: roedel@biozentrum.uni-wuerzburg.de
[3]World Wildlife Fund, Central African Regional Program Office, B.P. 9144 Libreville, Gabon;
Email: kamdem.toham@internetgabon.com

Received: 23 June 2003.
Accepted: 7 July 2003.

Hamadryad Vol. 27, No. 2, pp. 273 – 276, 2003

A record of the Arakan forest turtle *Heosemys depressa* (Anderson, 1875) from the southern Arakan Yoma Hills, Myanmar

(with one text-figure)

The Arakan forest turtle, *Heosemys depressa* (Anderson, 1875), is endemic to Myanmar and considered one of the world's least known chelonians (Ernst and Barbour, 1989; van Dijk, 1993). From 1875, when the species was first described, to 1908 only five *H. depressa* were reported in the literature, all from Rakhine (formerly known as "Arakan") State in western Myanmar (Iverson and McCord, 1997). These specimens presumably originated from the Arakan Yoma Hills, although specific locality data are lacking (Iverson and McCord, 1997). More recently, Platt et al. (2003) collected 17 *H. depressa* from the northern Arakan Yoma Hills (Fig. 1), and other specimens of uncertain provenance have been obtained from turtle markets in Yunnan Province, China (Iverson and McCord, 1997; P. C. H. Pritchard, pers. comm.; J. Behler, pers. comm.). Herein we provide data on five additional *H. depressa* from a previously unreported locality in the southern Arakan Yoma Hills.

We obtained these specimens during November 2000 from villagers living in the Rakhine Yoma Elephant Range (RYER; 18° 00' N; 94° 40' E), a protected area encompassing 175, 644 ha in the southern Arakan Yoma Hills (Fig. 1). This region is characterized by evergreen forest (Stamp, 1924; Stamp, 1930; Terra, 1944) of poorly known floristic composition (Salter, 1983) and extensive tracts of bamboo (*Melocanna bambusoides*) that developed as a result of long-term shifting cultivation and frequent anthropogenic fires (Soderstrom and Calderón, 1979).

We salvaged the carapaces (without plastrons) of four adults and the complete shell of an immature *H. depressa* that were captured locally and consumed by villagers (Table 1). These specimens are currently housed in the natural his-

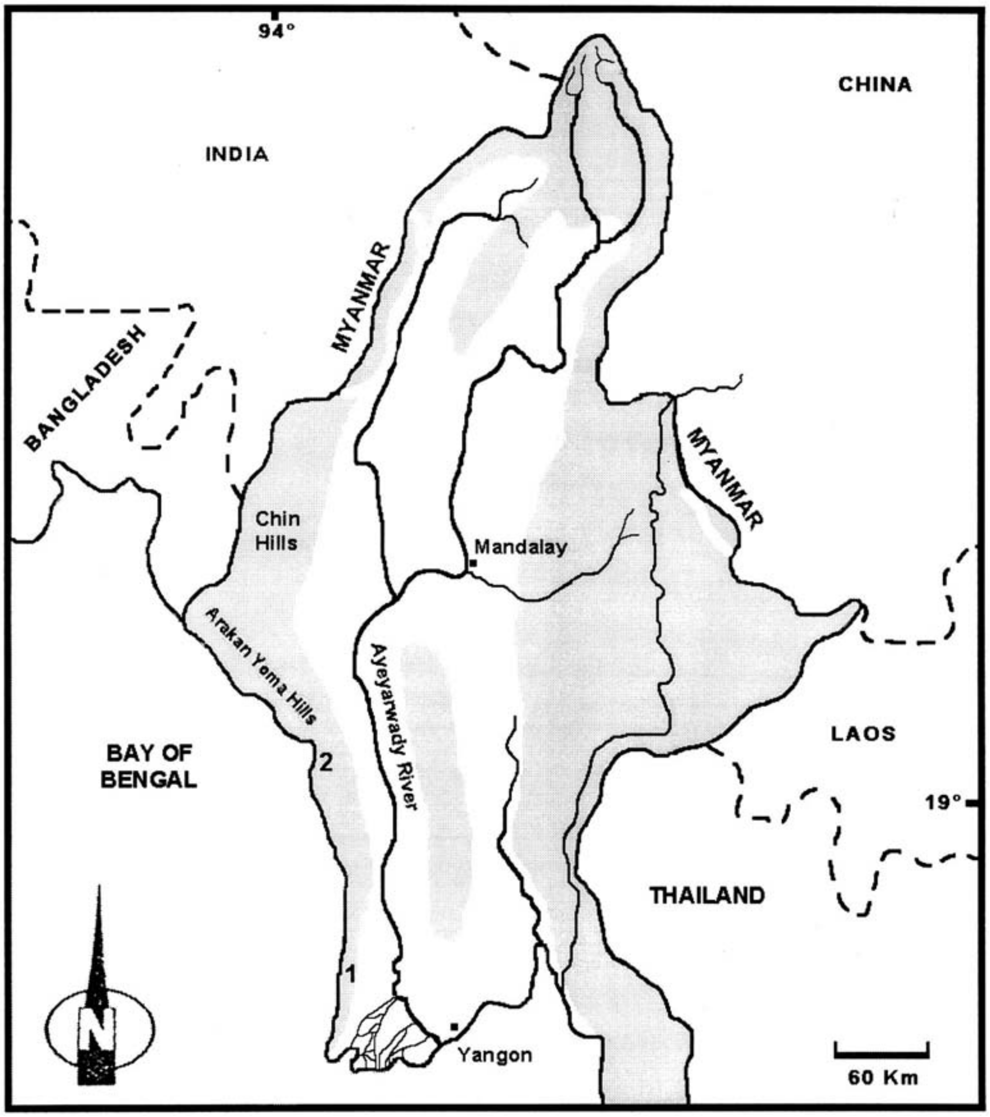

FIGURE 1: Map of Myanmar showing localities mentioned in the text. 1) Rakhine Yoma Elephant Range; 2) Region where Platt et al. (2003) collected 17 *Heosemys depressa* in 2000. Shading denotes hill ranges and mountains.

tory collection of the Wildlife Conservation Society Myanmar Program (Yangon). The left posterior pleural and marginal scutes of one carapace are discolored and fused with no discernible sutures, a description consistent with reports of fire damage to *Terrapene carolina* (Dodd et al., 1997). Dry season fires are frequent in RYER and probably account for these anomalies. The immature specimen lacks the obvious plastral concavity typical of males (Iverson and McCord, 1997), but cannot be reliably sexed as it is uncertain at what body size this characteristic becomes evident in *H. depressa*.

The RYER specimens extend the known distribution of *H. depressa* approximately 325 km south of recent collections from the northern Arakan Yoma Hills (Platt et al., 2003), and represent only the second group of specimens for which specific locality data are available. The complete distribution of *H. depressa* in

TABLE 1: Morphometric data (in mm) and annuli counts for five *Heosemys depressa* shells collected during November 2000 from the Rakhine Yoma Elephant Range, Myanmar. Shells 1 – 4 lacked plastrons. CL = midline carapace length; CW = maximum carapace width; PL = midline plastron length; PW = maximum plastron width.

Number	CL	CW	PL	PW	Annuli
1	234	165			12
2	240	160			15
3	224	153			~12
4	259	162			13
5	148	124	147	101	6

Myanmar remains ill-defined, but likely extends southwards to the southern terminus of the Arakan Yoma Hills and northwards into the Chin Hills, a mountain range contiguous with the Arakan Yomas. Future surveys are urgently needed to adequately define the distribution of this endemic chelonian.

Most importantly, the RYER specimens confirm the presence of *H. depressa* in the only protected area established within the currently recognized distribution of the species. *Heosemys depressa* is classified as Critically Endangered (facing an extremely high risk of extinction in the near future) due to continuing exploitation and limited distribution (IUCN, 2000), and RYER is therefore of global conservation significance for the continued survival of this species. Although originally established to protect Asian elephants (*Elephas maximus*), we recommend that the conservation mission of RYER be extended to include *H. depressa* and other chelonians. To this end, a ban on both commercial and subsistence harvesting of chelonians in the sanctuary is warranted. While the harvesting of chelonians for export to markets in southern China is widespread in Myanmar (Kuchling, 1995; Platt et al., 2000), commercial demand for *H. depressa* appears minimal (Platt et al., 2003). However, even low levels of subsistence harvesting are unlikely to be sustainable (Congdon et al., 1993, 1994) and potentially threaten the viability of *H. depressa* populations remaining within the sanctuary.

The Forest Department is thanked for granting permission to conduct fieldwork in Myanmar. The assistance of U Saw Tun Khaing and U Than Myint of the WCS Myanmar Program was instrumental to the success of our work. John Iverson (Earlham College), Peter Paul van Dijk (TRAFFIC Asia), Stephen Johnson (WCS library, New York), and the interlibrary loan librarians at Texas Tech University supplied critical references. This manuscript was improved by comments from Peter Paul van Dijk and William P. McCord.

LITERATURE CITED

ANDERSON, J. 1875. Description of some new Asiatic mammals and Chelonia. *Ann. & Mag. nat. Hist., Ser. 4*. 16: 282-285.

CONGDON, J. D., A. E. DUNHAM & R. C. VAN LOBEN SELS. 1993. Delayed sexual maturity and demographics of Blanding's turtles (*Emydoidea blandingii*): implications for conservation and management of long-lived organisms. *Conserv. Biol*. 7: 826-833.

________,_________&________ . 1994. Demographics of common snapping turtles (*Chelydra serpentina*): implications for conservation and management of long-lived organisms. *American Zool*. 34: 397-408.

DODD, C. K., JR., R. FRANZ & S. A. JOHNSON. 1997. Shell injuries and anomalies in an insular population of Florida box turtles (*Terrapene carolina bauri*). *Herpetol. nat. Hist*. 5: 66-72.

ERNST, C. H. & R. W. BARBOUR. 1989. Turtles of the world. Smithsonian Institution Press, Washington, D. C. 313 pp.

IUCN. 2000. [Online] The 2000 IUCN Red List of Threatened Species. IUCN, Gland. http://www.redlist.org.

IVERSON, J. B. & W. P. McCORD. 1997. Redescription of the Arakan forest turtle *Geoemyda depressa* Anderson 1875 (Testudines: Bataguridae). *Chelonian Conserv. & Biol*. 2: 384-389.

KUCHLING, G. 1995. Turtles at a market in western Yunnan: possible range extensions for some Asiatic chelonians in China and Myanmar. *Chelonian Conserv. & Biol*. 1: 223-226.

PLATT, S. G., WIN KO KO & KALYAR. 2000. Exploitation and conservation status of

tortoises and freshwater turtles in Myanmar. *Chelonian Res. Monogr*. 2: 95-100.

________,________,________ , MYO MYO, LAY LAY KHAING & T. R. RAINWATER. 2003. The ecology and conservation status of the Arakan forest turtle *Heosemys depressa* (Anderson, 1875) in western Myanmar. *Chelonian Conserv. & Biol*. (in press).

SALTER, J. A. 1983. Wildlife in the southern Arakan Yomas. Survey report and interim conservation plan. FO:BUR/80/006, Field Report 17/83. FAO, Rome. 24 pp.

SODERSTROM, T. R. & C. C. CALDERÓN. 1979. A commentary on the bamboos (Poaceae: Bambusoideae). *Biotropica* 11: 161-172.

STAMP, L. D. 1924. Notes on the vegetation of Burma. *Geograph. J.* 64: 231-237.

________. 1930. Burma: an undeveloped monsoon country. *Geograph. Rev.* 20:86-109.

TERRA, H. DE. 1944. Component geographic factors of the natural regions of Burma. *Ann. Assoc. American Geograph*. 34: 67-96.

VAN DIJK, P. P. 1993. Myanmar turtles: report on a preliminary survey of the Testudines of the Ayeyarwady Basin. Unpubl. report to Turtle Recovery Program, The World Conservation Union-IUCN SSC Tortoise & Freshwater Turtle Specialist Group. 34 pp.

Steven G. Platt[1,5], Soe Aung Min[2], Win Ko Ko[3] and Thomas R. Rainwater[4],
[1]Wildlife Conservation Society, 2300 Southern Blvd., Bronx, New York, 10460-1099, U.S.A.
[2]Nature and Wildlife Conservation Division, Forest Department, Rakhine Yoma Elephant Range, Gwa, Myanmar.
[3]Wildlife Conservation Society, Bldg. C-1, Aye Yeik Mon 1st Street, Yadanamon Housing Ave., Hlaing Township, Yangon, Myanmar.
[4]The Institute of Environmental and Human Health, Texas Tech University, Box 41163, Lubbock, Texas, 79409-1163, U.S.A.
[5]Current address: Oglala Lakota College, P.O. Box 490, Kyle, South Dakota, 57752-0490, U.S.A.

Received: 29 January 2003.
Accepted: 24 February 2003.

Hamadryad Vol. 27, No. 2, pp. 276 – 280, 2003

A report on sexual dimorphism in *Rana temporalis* (Günther, 1864)

(with three text-figures)

Sexual dimorphism is widespread in the animal kingdom and the amphibians are no exception. It has been reported in amphibians as secondary sexual characters among anurans from China (Liu, 1936), hylid frogs in tropical America (Duellman, 1970), and among a few genera of ranids from tropical evergreen forests of south India (Inger et al., 1984). Similarly, sexual dimorphism in size in *Rana temporalis* has been reported (see Boulenger, 1920), but it poses a problem when individuals have to be sexed using just one or a few morphological criteria. Dissection can provide the only non-ambiguous proof of the sex of an individual among adults. Identification of sex of individuals in a population is essential in understanding population demography of a species. Such studies have become more important in the wake of increasing reports of declining amphibian populations from different parts of the world.

Rana temporalis occurs in the riparian evergreen forests of the Western Ghats of south India and can be abundant on the forest floor. Thus, it can be a candidate for exploring and documenting characters that differentiated sexes within a population.

In this study, 24 individuals consisting 11 females and 13 males (WII denotes Wildlife Institute of India Museum; WII300, 302, 310, 311, 313, 314, 338, 347, 352, 356, 359, 309, 312, 320, 323, 326, 329, 332, 335, 337, 339, 350, 351 and 357) from Varagaliar, Anamalais, Western Ghats were examined between 16-18 November 1998. The duration of the study coincided with the broad season (post-monsoon) in which the species was found to breed in the locality. Some morphological characters were quantified using scores in the field on live animals. Subsequently, these individuals were killed in a solution of chloroform and fixed in 10% formalin prior to sexing. Two persons conclusively identified the

tortoises and freshwater turtles in Myanmar. *Chelonian Res. Monogr*. 2: 95-100.

________,_________,_________ , MYO MYO, LAY LAY KHAING & T. R. RAINWATER. 2003. The ecology and conservation status of the Arakan forest turtle *Heosemys depressa* (Anderson, 1875) in western Myanmar. *Chelonian Conserv. & Biol*. (in press).

SALTER, J. A. 1983. Wildlife in the southern Arakan Yomas. Survey report and interim conservation plan. FO:BUR/80/006, Field Report 17/83. FAO, Rome. 24 pp.

SODERSTROM, T. R. & C. C. CALDERÓN. 1979. A commentary on the bamboos (Poaceae: Bambusoideae). *Biotropica* 11: 161-172.

STAMP, L. D. 1924. Notes on the vegetation of Burma. *Geograph. J.* 64: 231-237.

________. 1930. Burma: an undeveloped monsoon country. *Geograph. Rev.* 20:86-109.

TERRA, H. DE. 1944. Component geographic factors of the natural regions of Burma. *Ann. Assoc. American Geograph*. 34: 67-96.

VAN DIJK, P. P. 1993. Myanmar turtles: report on a preliminary survey of the Testudines of the Ayeyarwady Basin. Unpubl. report to Turtle Recovery Program, The World Conservation Union-IUCN SSC Tortoise & Freshwater Turtle Specialist Group. 34 pp.

Steven G. Platt[1,5], Soe Aung Min[2], Win Ko Ko[3] and Thomas R. Rainwater[4],

[1]Wildlife Conservation Society, 2300 Southern Blvd., Bronx, New York, 10460-1099, U.S.A.

[2]Nature and Wildlife Conservation Division, Forest Department, Rakhine Yoma Elephant Range, Gwa, Myanmar.

[3]Wildlife Conservation Society, Bldg. C-1, Aye Yeik Mon 1st Street, Yadanamon Housing Ave., Hlaing Township, Yangon, Myanmar.

[4]The Institute of Environmental and Human Health, Texas Tech University, Box 41163, Lubbock, Texas, 79409-1163, U.S.A.

[5]Current address: Oglala Lakota College, P.O. Box 490, Kyle, South Dakota, 57752-0490, U.S.A.

Received: 29 January 2003.
Accepted: 24 February 2003.

Hamadryad Vol. 27, No. 2, pp. 276 – 280, 2003

A report on sexual dimorphism in *Rana temporalis* (Günther, 1864)

(with three text-figures)

Sexual dimorphism is widespread in the animal kingdom and the amphibians are no exception. It has been reported in amphibians as secondary sexual characters among anurans from China (Liu, 1936), hylid frogs in tropical America (Duellman, 1970), and among a few genera of ranids from tropical evergreen forests of south India (Inger et al., 1984). Similarly, sexual dimorphism in size in *Rana temporalis* has been reported (see Boulenger, 1920), but it poses a problem when individuals have to be sexed using just one or a few morphological criteria. Dissection can provide the only non-ambiguous proof of the sex of an individual among adults. Identification of sex of individuals in a population is essential in understanding population demography of a species. Such studies have become more important in the wake of increasing reports of declining amphibian populations from different parts of the world.

Rana temporalis occurs in the riparian evergreen forests of the Western Ghats of south India and can be abundant on the forest floor. Thus, it can be a candidate for exploring and documenting characters that differentiated sexes within a population.

In this study, 24 individuals consisting 11 females and 13 males (WII denotes Wildlife Institute of India Museum; WII300, 302, 310, 311, 313, 314, 338, 347, 352, 356, 359, 309, 312, 320, 323, 326, 329, 332, 335, 337, 339, 350, 351 and 357) from Varagaliar, Anamalais, Western Ghats were examined between 16-18 November 1998. The duration of the study coincided with the broad season (post-monsoon) in which the species was found to breed in the locality. Some morphological characters were quantified using scores in the field on live animals. Subsequently, these individuals were killed in a solution of chloroform and fixed in 10% formalin prior to sexing. Two persons conclusively identified the

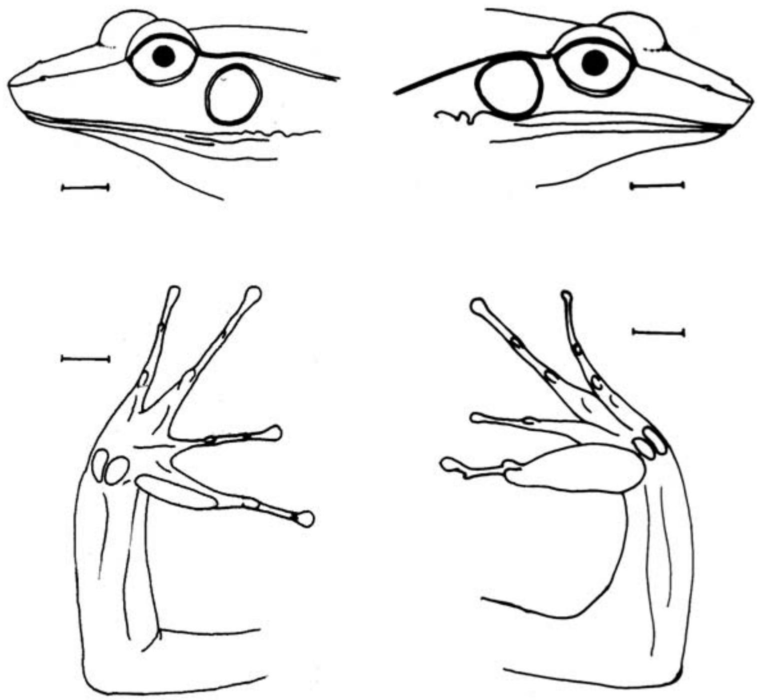

FIGURE 1: Diagramatic representation of variation in the tympanic area and musculature of the forearm in *Rana temporalis*. Figures (a) and (c) of an adult female, (b) and (d) of an adult male were drawn from individuals WII 356 and WII 323, respectively. Figure (a) scale 20 mm; figure (b) scale 30 mm; figure (c) scale 30 mm; figure (d) scale 50 mm.

sex of the individuals independently after dissection. Between the two, there was 96% concurrence in the identity of the sexes. Morphometric data on the individuals were taken a month after preservation of the individuals.

The following measurements were obtained with a Mitutoyo™ dial vernier callipers (to the nearest 0.1 mm): distance from tip of snout to vent or snout vent length (SVL); distance from angle of jaw to tip of snout or head length (HL); greatest height of the head with the head held perpendicular to the arm of the callipers (HH); greatest diameter of tympanum (TD); the diameter of the widest portion at the base of the humerus (FAD). The following scores were given in the field for the condition of the tympanum using tympanum score (TS); the contrast in colour of the dorsum with the flank using colour contrast score (COLS); the amount of musculature on the inside of the elbow using forearm musculature score (FAMS).

The scores were given a value from 1 to 3. The least score for this parameter was 1, the maximum 3. A score of 1 was assigned for TS when the tympanum was entirely free from the fold of skin adjoining the upper jaw (the upper lip) and the dorsolateral fold (Fig. 1a). A score of 2 was given when the tympanum is distorted only on one end, either by the dorsolateral fold or the upper lip. A score of 3 was given to individuals that had their tympanum distorted since they were totally packed between the dorsolateral fold and the upper lip (Fig. 1b). COLS ranged from 1 to 3. Individuals had increasing contrast in colour of their dorsum and their flank from 1 to 3. Usually individuals that had a score of 1 were melanistic with little or no contrast in the colour of their dorsum. The forearm of *R. temporalis* has a muscle bridge connecting the humerus and the radio ulna bones. This bridge muscle is prominent in some individuals and nearly absent in others. The adaptive significance of this muscle for the males could be to grip the female during amplexus.

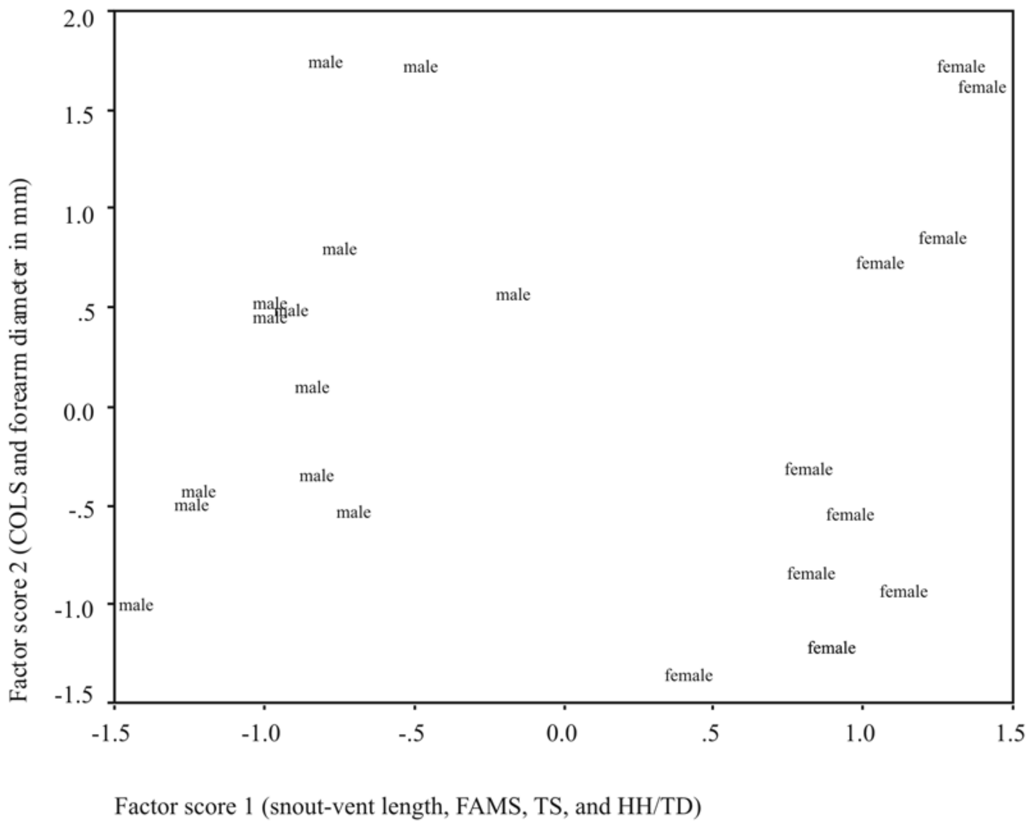

FIGURE 2: Biplot of individuals of *Rana temporalis* using the first two factors of principal component analysis. The factor scores represent morphological measurements of 24 individuals used in the analysis.

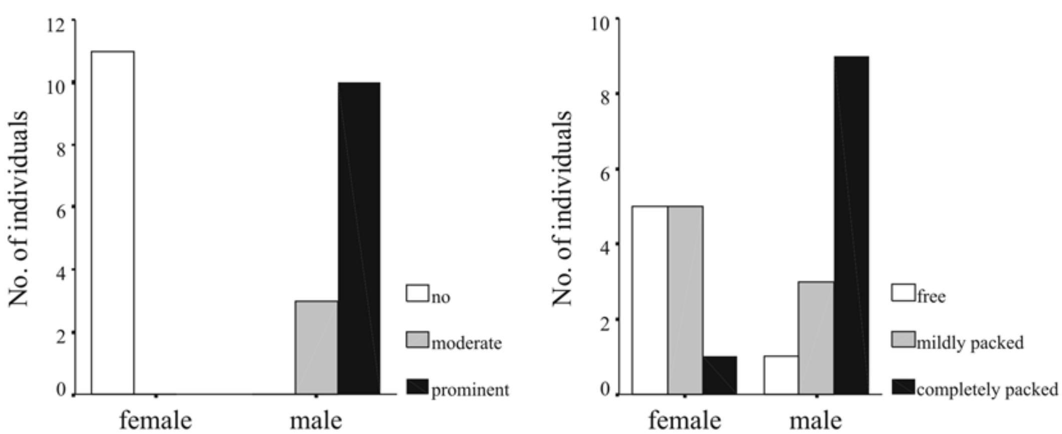

FIGURE 3: Left: The distribution of FAMS among the sexes in *R. temporalis*. Right: The distribution of TS among the sexes in *R. temporalis*.

FAMS was assigned to each individual that was sexed based on the extent of bridge muscle on the inside of the elbow. A score was given to live individuals after the fore limb was bent with the radio-ulna at right angles to the humerus and the inside of the elbow did not have any musculature when the score was one (Fig. 1c). A score of 2 or 3 was given when there was less or more musculature on the inside of the elbow (Fig. 1d).

The tympanum diameter (TD), eye diameter (ED), head height (HH), fore arm diameter (FAD) and snout vent length (SVL) was measured for all individuals after sexing following euthanasia. The ratios HH/TD and SVL/FAD were used in order to substantiate the subjective scores that were assigned to the nature of the tympanum and the musculature on the inside of the elbow. Principal component analysis with Varimax Rotation with Kaiser Normalization of SPSS 8.0 (Norusis, 1996) was used to reduce the parameters in the data. The rotation that converged in three iterations was used to identify the parameters that separate sexes in *R. temporalis*. The two axes explained 65% of the variation in the data. The first component effectively separates the sexes (Fig. 2) suggesting that the males and females of *R. temporalis* can be distinguished using the above characters. The parameters FAMS, SVL, HH/TD, SVL/FAD, TS and FAD have high loading in the first factor and are therefore crucial parameters in separating the sexes (Table 1). The factor 1 has from left to right increasing snout-vent length, decreasing forearm musculature score, increasing ratios of head height with tympanum diameter, snout vent length with forearm diameter, decreasing tympanum score and increasing forearm diameter (Fig. 2).

The importance of FAMS, SVL, HH/TD, SVL/FAD, TS, COLS and FAD in differentiating the sexes was further explored. The variables SVL, HH/TD, SVL/FAD and FAD followed the assumption of normally (Kolmogorov Smirnov test, $P > 0.05$) except for SVL, which was significantly different ($P = 0.036$), mainly due to the strong size based dimorphism among the individuals. The sexes were significant different in SVL, HH/TD, SVL/FAD and FAD (one way ANOVA, $F = 536.5$, 49.7, 16.2 and 32.4 respectively; $P < 0.01$). The COLS was found to be unrelated of the sex of the individuals (Fisher's exact test, $P = 0.303$). The FAMS and TS were significantly dependent on the sex of the individual (Fisher's exact tests, $P < 0.01$) with females showing no musculature on the inside of the arm and males having strong musculature (Fig. 3a). The tympanum was also larger than females and the outer rim of their tympanum distorted in the males (Fig. 3b). Therefore, in *R. temporalis* apart from size of the individuals, the nature of the forearm musculature and the tympanum varies with their sex.

The forearm musculature or hypertrophied forelimb in amphibians as nuptial excrescence has been documented in *Leptodactylus* (Lynch, 1971), in hylids such as *Plectrohyla* (Duellman, 1970) and in Asian ranids (Dubois, 1975). It is suggested that such nuptial excrescence obviously are associated with amplexus, but they may also play an important role in male-male combat (Duellman and Trueb, 1994; Katsikaros and Shine, 1997). In most anurans, the tympanum of relatively similar size in both sexes, however in some species of *Rana, Ptychadena, Conraua* and *Hylorana,* tympanum is larger in males (Duellman and Trueb, 1994). The function of a larger tympanum relative to the body size is unknown (Duellman and Trueb, 1994). It is reasonable to conclude that *Rana temporalis* breeding populations show sexual dimorphism in characters such as forearm musculature and nature of the tympanum. These characters, apart from snout vent length can be useful to identify sex of breeding individuals in the field.

The study was carried out as part of a collaborative project of the Wildlife Institute of India and US Fish and Wildlife Service. I thank Dr. Ajith Kumar for discussions and initiating me with the analyses. My field assistants Arumugam, Mani and Selamban helped me in my work and accompanied me to the forests whenever I wanted, I am extremely grateful for for their services.

LITERATURE CITED

BOULENGER, G.A. 1920. A monograph on the South Asian, Papuan, Melanesian and Australian frogs of the genus *Rana*. *Rec. Indian Mus.* 20: 1-226.

DUBOIS, A. 1975. Un nouveau sous-genre (*Paa*) et trois nouvelles especes du genre *Rana*. Remarques sur la phylogenie des Ranides (Amphibiens, Anoures). *Bull. Mus. Nat. Hist . nat.* 3, 324 (Zool. 231): 1093-1115.

DUELLMAN, W. E. 1970. The hylid frogs of middle of America. *Monogr. Mus. nat. Hist., Univ. Kansas* 1: 1-753.

________& L. TRUEB. 1994. Biology of amphibians. The Johns Hopkins Press, Maryland. xxi + 670 p.

INGER, R. F., H. B. SHAFFER, M. KOSHY & R. BAKDE. 1984. A report on a collection of amphibians and reptiles from the Ponmudi, Kerala, south India. *J. Bombay nat. Hist. Soc.* 81(2): 406-427.

KATSIKAROS, K. & R. SHINE. 1997. Sexual dimorphism in the tusked frog *Adelotus brevis* (Anura: Myobatrachidae): the roles of natural selection and sexual selection. *Biol. J. Linnean Soc.* 60: 39-51.

LIU, C. C. 1950. Amphibians of Western China. *Fieldiana: Zool. Mem*. 2 1-400 + 10 plates.

LYNCH, J. D. 1971. Evolutionary relationships, osteology, and zoogeography of leptodactyloid frogs. *Mus. Publ. Mus. nat. Hist. Univ. Kansas* 53: 1-238.

NORUŠIS, M. J. 1989. SPSS/PC+ for the IBM PC/XT/AT. SPSS Inc. Chicago. xvi + 606 pp.

Karthikeyan Vasudevan
Wildlife Institute of India, P.O. Box 18
Dehradun 248001, India.
Email: karthik@wii.gov.in

Received: 25 July 2002.
Accepted: 26 April 2003.

Hamadryad Vol. 27, No. 2, pp. 280 – 281, 2003

First record of *Ophisops beddomei* (Jerdon, 1870) from Gujarat State, western India

On 25 November, 1999 at 11:30 h, a lacertid lizard was observed foraging in a grassy patch near the Bhuvero Temple, within the Ratanmahal Plateau of Ratanmahal Wildlife Sanctuary (RWS), Dahod District, Gujarat (74º 0' – 74º 12' E 22º 30' – 22º 40' N). On examination, it was identified as *Ophisops beddomei* (Jerdon, 1870). Two additional specimens of the species were collected from the RWS forest area of Bhuvera and Gumali, between altitudes of 550-600 m above sea level. The lizards were active during the day, foraging in grasslands with large boulders.

Description.- Dorsally olive-brown and laterally dark-brown with a light golden-yellow lateral streak from loreal region to posterior part of hind limbs; belly light yellow or white; limbs dark brown with yellow spots and tail light olive brown. Two specimens were deposited in the museum of the Bombay Natural History Society (BNHM 1562 [1] & 1562 [2]), Mumbai. A third specimen was damaged and could not be mea-

TABLE 1: Measurements (in mm) and other details of two specimens of *Ophisops beddomei* from Ratanmahal Wildlife Sanctury, Gujarat, India.

	BNHS 1562(1) Locality: Bhuvero	BNHS 1562(2) Locality: Ratanmahal Plateau
Sex	male	male
Snout-vent length	36.00	37.00
Tail length	57.30	49.00
Angle of jaws to snout tip	08.56	07.00
Posterior edge of fore limb at insertion to body and anterior edge of hind limbs	18.52	20.0
Eye diameter	01.20	01.38
Anterior-most point of eye and nostrils	03.26	03.28
Anterior-most point of eye and tip of snout	04.24	04.20

LITERATURE CITED

BOULENGER, G.A. 1920. A monograph on the South Asian, Papuan, Melanesian and Australian frogs of the genus *Rana*. *Rec. Indian Mus.* 20: 1-226.

DUBOIS, A. 1975. Un nouveau sous-genre (*Paa*) et trois nouvelles especes du genre *Rana*. Remarques sur la phylogenie des Ranides (Amphibiens, Anoures). *Bull. Mus. Nat. Hist . nat.* 3, 324 (Zool. 231): 1093-1115.

DUELLMAN, W. E. 1970. The hylid frogs of middle of America. *Monogr. Mus. nat. Hist., Univ. Kansas* 1: 1-753.

________& L. TRUEB. 1994. Biology of amphibians. The Johns Hopkins Press, Maryland. xxi + 670 p.

INGER, R. F., H. B. SHAFFER, M. KOSHY & R. BAKDE. 1984. A report on a collection of amphibians and reptiles from the Ponmudi, Kerala, south India. *J. Bombay nat. Hist. Soc.* 81(2): 406-427.

KATSIKAROS, K. & R. SHINE. 1997. Sexual dimorphism in the tusked frog *Adelotus brevis* (Anura: Myobatrachidae): the roles of natural selection and sexual selection. *Biol. J. Linnean Soc.* 60: 39-51.

LIU, C. C. 1950. Amphibians of Western China. *Fieldiana: Zool. Mem*. 2 1-400 + 10 plates.

LYNCH, J. D. 1971. Evolutionary relationships, osteology, and zoogeography of leptodactyloid frogs. *Mus. Publ. Mus. nat. Hist. Univ. Kansas* 53: 1-238.

NORUŠIS, M. J. 1989. SPSS/PC+ for the IBM PC/XT/AT. SPSS Inc. Chicago. xvi + 606 pp.

Karthikeyan Vasudevan
Wildlife Institute of India, P.O. Box 18
Dehradun 248001, India.
Email: karthik@wii.gov.in

Received: 25 July 2002.
Accepted: 26 April 2003.

Hamadryad Vol. 27, No. 2, pp. 280 – 281, 2003

First record of *Ophisops beddomei* (Jerdon, 1870) from Gujarat State, western India

On 25 November, 1999 at 11:30 h, a lacertid lizard was observed foraging in a grassy patch near the Bhuvero Temple, within the Ratanmahal Plateau of Ratanmahal Wildlife Sanctuary (RWS), Dahod District, Gujarat (74º 0’ – 74º 12’ E 22º 30’ – 22º 40’ N). On examination, it was identified as *Ophisops beddomei* (Jerdon, 1870). Two additional specimens of the species were collected from the RWS forest area of Bhuvera and Gumali, between altitudes of 550-600 m above sea level. The lizards were active during the day, foraging in grasslands with large boulders.

Description.- Dorsally olive-brown and laterally dark-brown with a light golden-yellow lateral streak from loreal region to posterior part of hind limbs; belly light yellow or white; limbs dark brown with yellow spots and tail light olive brown. Two specimens were deposited in the museum of the Bombay Natural History Society (BNHM 1562 [1] & 1562 [2]), Mumbai. A third specimen was damaged and could not be mea-

TABLE 1: Measurements (in mm) and other details of two specimens of *Ophisops beddomei* from Ratanmahal Wildlife Sanctury, Gujarat, India.

	BNHS 1562(1) Locality: Bhuvero	BNHS 1562(2) Locality: Ratanmahal Plateau
Sex	male	male
Snout-vent length	36.00	37.00
Tail length	57.30	49.00
Angle of jaws to snout tip	08.56	07.00
Posterior edge of fore limb at insertion to body and anterior edge of hind limbs	18.52	20.0
Eye diameter	01.20	01.38
Anterior-most point of eye and nostrils	03.26	03.28
Anterior-most point of eye and tip of snout	04.24	04.20

Anterior edge of ear opening to posterior-most eye corner	03.74	02.88
Greatest diameter of ear opening	01.30	01.24
Internostril distance	01.60	01.24
Upper labials (touching eye) R/L	8 (5th)/9 (6th)	8/8 (5th)
Lower labials R/L	8/7	7/7
Frontonasals	2	2
Prefrontals	2	2
Ventrals	22	22
Dorsal scale rows	30	30
Hind limbs lamellae 1:2:3:4:5	6:12:11:20:11	6:8:14:18:12
Femoral pores	10:10	10-10

sured. Measurements and scalation details for the two BNHM specimens are in Table 1.

According to Smith (1935), this species is distributed in Karnataka (south Kanara plains and Brahmagiri hills) and Maharashtra (Satara District). The present distribution record of the species from RWS, Dahod District, Gujarat is therefore an extension of the known range of the species by ca. 1,100 km to the north.

I thank the Director, Gujarat Ecological Education Foundation, Gandhinagar, India for logistic support and permission for the study.

LITERATURE CITED

SMITH, M. A. 1935. The fauna of British India including Ceylon and Burma. Reptilia and Amphibia, Vol. II. Sauria. Taylor and Francis, London. xiii + 440 pp.

Raju Vyas, Sayaji Baug Zoo, Vadodara-390 018, Gujarat, India.
Email: razoovyas@hotmail.com

Received: 8 June 2003.
Accepted: 2 July 2003.

Hamadryad Vol. 27, No. 2, pp. 281 – 284, 2003

The first report on the herpetofauna of Pulau Sembilang and Pulau Seribuat, Pahang, West Malaysia

Seribuat Archipelago is located in the southern section of the South China Sea off the south-east coast of Peninsular Malaysia. It is composed of 32 islands, of which only six have been herpetologically documented; Pulau Tioman (Day, 1990; Grismer et al., 2002; Hien et al., 2001; Hendrickson, 1966a; 1996b; Lim and Lim, 1999), Pulau Aur (Escobar et al., 2001; 2003a; Grismer et al., 2001a), Pulau Tulai (Grismer et al., 2001b; 2002; Hendrickson, 1966a; 1966b) Pulau Pemanggil (Youmans et al., 2002), Pulau Dayang (Wood et al., 2003), and Pulau Tinggi (Escobar et al., 2003a). Field wok was conducted on Pulau Seribuat and Pulau Sembilang with the intention of composing a preliminary checklist of the islands' herpetological diversity. A total of 10 lizards and two frogs were observed.

Pulau Sembilang (103° 53' E; 2° 41' N) is a small oblong island (2.0 x 2.1 km) located 17.6 km north-east coast of Peninsular Malaysia and 0.7 km west of the nearby Pulau Seribuat. The islands are connected at low tide by a shallow sand bar. Pulau Sembilang is low lying and consists of volcanic rocks and wind blown coastal vegetation with a small peak (232 m) on its northern side. The vegetation on the peaks appears more dense than the low-lying regions. Mangrove vegetation nearly surrounds the periphery of the island and small fresh water streams that flow into the ocean occur on its western side.

Pulau Seribuat (103° 55' E; 2° 41' N) is a small cylindrical island (2.6 x 3.3 km) located 16.0 km north-east of Peninsular Malaysia and 0.7 km from Pulau Sembilang. Pulau Seribuat is similar to Pulau Sembilang in that the interiors of both are composed of low-lying volcanic rocks and wind blown coastal vegetation. There is a low peak (139 m) on the southern side of the island, which has a little more forest then the lower less mesic regions. The eastern periphery of the island maintains extensive mangrove swamps. A

Anterior edge of ear opening to posterior-most eye corner	03.74	02.88
Greatest diameter of ear opening	01.30	01.24
Internostril distance	01.60	01.24
Upper labials (touching eye) R/L	8 (5th)/9 (6th)	8/8 (5th)
Lower labials R/L	8/7	7/7
Frontonasals	2	2
Prefrontals	2	2
Ventrals	22	22
Dorsal scale rows	30	30
Hind limbs lamellae 1:2:3:4:5	6:12:11:20:11	6:8:14:18:12
Femoral pores	10:10	10-10

sured. Measurements and scalation details for the two BNHM specimens are in Table 1.

According to Smith (1935), this species is distributed in Karnataka (south Kanara plains and Brahmagiri hills) and Maharashtra (Satara District). The present distribution record of the species from RWS, Dahod District, Gujarat is therefore an extension of the known range of the species by ca. 1,100 km to the north.

I thank the Director, Gujarat Ecological Education Foundation, Gandhinagar, India for logistic support and permission for the study.

LITERATURE CITED

SMITH, M. A. 1935. The fauna of British India including Ceylon and Burma. Reptilia and Amphibia, Vol. II. Sauria. Taylor and Francis, London. xiii + 440 pp.

Raju Vyas, Sayaji Baug Zoo, Vadodara-390 018, Gujarat, India.
Email: razoovyas@hotmail.com

Received: 8 June 2003.
Accepted: 2 July 2003.

Hamadryad Vol. 27, No. 2, pp. 281 – 284, 2003

The first report on the herpetofauna of Pulau Sembilang and Pulau Seribuat, Pahang, West Malaysia

Seribuat Archipelago is located in the southern section of the South China Sea off the south-east coast of Peninsular Malaysia. It is composed of 32 islands, of which only six have been herpetologically documented; Pulau Tioman (Day, 1990; Grismer et al., 2002; Hien et al., 2001; Hendrickson, 1966a; 1996b; Lim and Lim, 1999), Pulau Aur (Escobar et al., 2001; 2003a; Grismer et al., 2001a), Pulau Tulai (Grismer et al., 2001b; 2002; Hendrickson, 1966a; 1966b) Pulau Pemanggil (Youmans et al., 2002), Pulau Dayang (Wood et al., 2003), and Pulau Tinggi (Escobar et al., 2003a). Field wok was conducted on Pulau Seribuat and Pulau Sembilang with the intention of composing a preliminary checklist of the islands' herpetological diversity. A total of 10 lizards and two frogs were observed.

Pulau Sembilang (103° 53' E; 2° 41' N) is a small oblong island (2.0 x 2.1 km) located 17.6 km north-east coast of Peninsular Malaysia and 0.7 km west of the nearby Pulau Seribuat. The islands are connected at low tide by a shallow sand bar. Pulau Sembilang is low lying and consists of volcanic rocks and wind blown coastal vegetation with a small peak (232 m) on its northern side. The vegetation on the peaks appears more dense than the low-lying regions. Mangrove vegetation nearly surrounds the periphery of the island and small fresh water streams that flow into the ocean occur on its western side.

Pulau Seribuat (103° 55' E; 2° 41' N) is a small cylindrical island (2.6 x 3.3 km) located 16.0 km north-east of Peninsular Malaysia and 0.7 km from Pulau Sembilang. Pulau Seribuat is similar to Pulau Sembilang in that the interiors of both are composed of low-lying volcanic rocks and wind blown coastal vegetation. There is a low peak (139 m) on the southern side of the island, which has a little more forest then the lower less mesic regions. The eastern periphery of the island maintains extensive mangrove swamps. A

small stream runs near the base of the southern peak.

Collections were made on the south-eastern section of Pulau Seribuat between 1000 and 1400 h on 24 March 2003 and between 2000 and 2300 h on 25 March 2003. Collections were made on Pulau Sembilang between 1100 and 1500 h on 25 March 2003 on the western portion of the island. Liver tissue and tail tips were taken from representative specimens and preserved in 90% ethanol. Specimens were preserved using 10% formalin and stored in 70% ethanol. Specimens collected are listed below and deposited in the Forest Research Institute Malaysia (FRIM), Kepong, Kuala Lumpur, Malaysia. Photographic vouchers are deposited in the La Sierra University Photographic Collection the Department of Biology, La Sierra University, Riverside, California, U.S.A.

Anura (frogs)

Polypedates leucomystax (Gravenhorst, 1829)(FRIM 0581-0585, Seribuat; 0613, Sembilang).- Two tadpoles were taken from a drying pool in a stream at 1100 h on Pulau Seribuat, adults were collected at night along a small stream, in the trees, ca. 2 m above the ground, and in low-lying vegetation.

Fejervarya cancrivora (Gravenhorst, 1829)(FRIM 0580, Seribuat; 0610-0612, Sembilang).- Individuals were observed near the beach in a dried stream bed at 1300 h on Pulau Sembilang. An additional specimen was collected at night from the inertial zone on Pulau Seribuat where the freshwater stream meets the ocean.

Squamata (lizards)

Aphaniotis fusca (Peters, 1864)(FRIM 0586, Seribuat; 0614-0616, Sembilang).- Many specimens were collected between 1100 and 1220 h on Pulau Seribuat and Pulau Sembilang. All were 1-9 m above the ground on the trunks of small trees ranging from 0.3 to 0.8 m in diameter.

Cnemaspis kendallii (Gray, 1845)(FRIM 0587-0589, Seribuat; 0617, Sembilang).- Several specimens were collected on Pulau Seribuat and Pulau Sembilang along stream beds in the forest. Specimens were observed on rocks and logs between 1000 and 1200 h near a stream bed.

Cyrtodactylus sp. (FRIM 0590-0597, Seribuat; 0618, Sembilang).- Several individuals were collected on the beach and within the intertidal zones near mangrove swamps on Pulau Seribuat and Pulau Sembilang. All were found between 1900 and 2200 h. During the day, specimens were found beneath dead coconut husks and pieces of plywood debris on the beach. This population represents a new species whose description is in preparation.

Gekko monarchus (Duméril and Bibron 1836)(FRIM 0600-0601, Seribuat).- Two specimens were collected on Pulau Seribuat, ca. 1 m above ground on trees next to the stream bed. The first specimen was found at 2021 h on a small (0.5 m diameter) tree, ca. 0.5 m above the ground. The second was found on a tree near the edge of a stream.

Hemidactylus frenatus (Duméril and Bibron, 1836)(FRIM 0598-0599, Seribuat; 0619, Sembilang).- Two specimens on Pulau Seribuat were found in a tree, ca. 2 m above the ground in the mangrove swamps. Both were collected between 1000 and 1300 h.

Ptychozoon kuhlii (Stejneger, 1902)(FRIM 0602, Seribuat).- One well-developed embryo was taken from an egg attached to a medium sized tree (0.5 m in diameter), ca. 4 m above the ground along a dry stream bed at 1126 h on Pulau Sembilang.

Emoia atrocostata (Lesson, 1830)(FRIM 0603-0605, Seribuat).- Five individuals were collected in the intertidal zone and mangrove swamps on Pulau Seribuat. All were taken between 1000 and 1200 h. All had a light orange ventral colouration.

Lygosoma bowringii (Günther 1864)(FRIM 0606, Seribuat; 0621, Sembilang).- Three specimens were collected on a sandy beach under a log near the base of a tree on Pulau Seribuat and another near the base of at tree on Pulau Sembilang. Individuals attempted to burrower into the sand to escape capture.

Eutropis multifasciata (Kuhl, 1820)(FRIM 0607-0609, Seribuat; 0622, Sembilang).- Eight specimens were observed from throughout the

locations visited on both Pulau Sembilang and Pulau Seribuat. Most were collected while basking on the forest floor on rocks, near trees, or in the leaf litter.

Unconfirmed species

Boiga dendrophila (Boie, 1827).- The caretaker of a radio tower on the western side of the Pulau Seribuat reported seeing a long black snake with yellow bands on the body. It is assumed to be *Boiga dendrophlia.* Future fieldwork is planned to confirm this identification.

Varanus salvator (Laurenti, 1768).- One specimen was seen on Pulau Seribuat walking along the beach foraging for food in the intertidal zone.

The amphibians and reptiles of Pulau Seribuat are a subset of the species found on Pulau Sembilang. We can make this assumption based on the ecological similarity of the two islands and their close proximity. However, additional fieldwork will probably demonstrate that these islands share the same species. The only difference in the herpetofauna at this point is the presence of *Ptychozoon kuhlii* on Sembilang and *Hemidactylus frenatus* and *Gekko monarchus* on Seribuat. We expect to find these two species on Seribuat with future fieldwork.

We are most grateful to Sahir bin Othman of the Department of Wildlife, Jabatan Perlindungan Hidupan Liar dan Taman Negara (PERHILITAN) for permission to conduct fieldwork in the Seribuat Archipelago. For comments on the manuscript we would like to thank L. L. Grismer. This fieldwork was supported by grants from the University Research Council of La Sierra University and the Rychman Endowment Funding

LITERATURE CITED

DAY, M. 1990. Zoological research. *In*: University of Bristol Tioman Archipelago Expedition, Peninsular Malaysia, 1988, Final Report. pp: 25-43. M. Day & T. Mowbray (Eds). Unpublished report.

ESCOBAR, R. A., III, S. GUERRERO, J. W. PINEDO, P. A. JONES & H. KAISER. 2001. First report on the herpetofauna of Pulau Aur, Johor, West Malaysia. *Hamadryad* 26(2): 350-353.

________J. CASTRO, D. MORGAN, S. M. HOVER, T. R. SZUTZ, K. McCLOSKEY & R. GREGORY. 2003a. Additions to the herpetofauna of Pulau Aur, Johor, West Malaysia. *Hamadryad* 27(2): 287-288.

_____, _____, _____, _____, _____, _____ & _____. 2003b. First report of the herpetofauna of Pulau Tinggi, Johor, West Malaysia. *Hamadryad* 27(2): 259-262.

GRISMER, L. L, J. A. McGUIRE, R. A. SOSA & H. KAISER. 2002. Revised checklist and comments on the terrestrial herpetofauna of Pulau Tioman, Peninsular Malaysia. *Herpetol. Rev.* 33(1): 26-29.

________, N. S. YAAKOB, B. L. LIM, T. M. LEONG, I. DAS, R. A. SOSA, J. L. GRISMER, K. M. CRANE, R. E. DIAS, S. V. FIGUEROA, C. A. LEDBETTER, S. C. NEWBOLD, S. R. NEWBOLD, C. P. PATEL, J. CASTRO, R. A. ESCOBAR, III, S. GUERRERO, J. W. PINEDO, J. TRUJILLO & H. KAISER. 2001a. First report on the herpetofauna of Pulau Aur, Johor, West Malaysia. *Hamadryad* 26(2): 350-353.

_____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____ & _____. 2001b. Report on the herpetofauna of Pulau Tulai, West Malaysia. *Hamadryad* 26(2): 369-371.

HENDRICKSON, J. R. 1966a. Observations on the fauna of Pulau Tioman and Pulau Tulai. 5. The Reptiles. *Bull. Nat. Mus. Singapore* 34: 53-71.

________. 1966b. Observations on the fauna of Pulau Tioman and Pulau Tulai. 6. *Bull. Nat. Mus Singapore* 34: 72-84.

HIEN, P., W. GROSSMANN & C. SCHAFER. 2001. Beitrag zur Kenntnis der landbewohnenden Reptilienfauna von Pulau Tioman, West- Malaysia. *Sauria, Berlin* 23: 11-28.

LIM, K. K. P. & L. J. LIM. 1999. The terrestrial herpetofauna of Pulau Tioman, Peninsular Malaysia. *Bull. Raffles Mus*. Suppl. (6): 131-155

WOOD, P. L., T. M. YOUMANS, C. RAYNOR, J. M. BERNARD, N. HINOJOSA, T. DYER, S. ANDREIKO, P. P. VAN DIJK, W. WUERTZ & L. S. YEEN. 2003. First report on the herpetofauna of Pulau Dayang, Pahang, West Malaysia. *Hamadryad* 27(2): 285-286.

YOUMANS, T. M., R. A. ESCOBAR, III, J. L. GRISMER, L. L. GRISMER & R. JOHNSON. 2002. First report on herpetofauna of Pulau Pemanggil. *Hamadryad* 27(1): 148-149.

Perry L. Wood, Thomas R. Szutz, Timothy M. Youmans & Jesse L. Grismer
Department of Biology, La Sierra University, Riverside, California 92515-8247, U.S.A.
Email: Perrwood@lasierra.edu, tomszutz@hotmail.com

Received: 4 July 2003.
Accepted: 25 July 2003.

Hamadryad Vol. 27, No. 2, pp. 284 – 285, 2003

First report on the herpetofauna of Pulau Dayang, Pahang, West Malaysia

Pulau Dayang is a small oblong-shaped island (1.9 x 3.8 km) located ca. 0.08 km north of Pulau Aur in the south-eastern portion of the Seribuat Archipelago at the southern end of the South China Sea. The island consists of a low range of granitic rock outcroppings with an elevated middle section being composed a giant boulder forming a peak. The majority of the island is covered with coastal vegetation which has been severely degraded. Small streams occur on the northern end of the island.

The herpetofauna of the adjacent island of Aur is known to have one frog, 14 lizards, and 4 snakes (Grismer et al, 2001; Escobar et al., 2003) but no field investigations have taken place on Pulau Dayang. Therefore, a herpetological survey was conducted with the intent of composing a preliminary checklist of the species diversity and to obtain tissue samples for DNA of representative specimens. A total of five lizards and one snake were collected.

Collections were made between 1200 and 1700 h on 22 July 2002 on the southern portion and summit of the island. Liver tissue and tail tips were taken from representative specimens and preserved in 90% ethanol. Specimens were preserved using 10% formalin and stored in 70% ethanol. Specimens collected are listed below. Museum acronyms are ZRC, The Zoological Reference Collection, at the Raffles Museum of Biodiversity Research, National University of Singapore and LSUPC, La Sierra University Photographic Collection at the Department of Biology, La Sierra University, Riverside, California.

Squamata (lizards):

Cnemaspis sp. (Das & Grismer 2003) (LSUPC.L7229).- One specimen was found on a rock under human trash, leaves, and pieces of wood at approximately 1650 h. This species was thought to be endemic to the adjacent Pulau Aur.

Hemidactylus frenatus (Duméril & Bibron 1836) (ZRC.2.5491).- Several individuals were seen in human habitations. One specimen was collected on the same rock as the *Cnemaspis* sp..

Gekko monarchus (Duméril & Bibron 1836) (ZRC.25493).- Two specimens were caught on the same rock as the *H. frenatus* and *Cnemaspis* sp. at approximately 1655 h under debris.

Mabuya mutifasciata (Kuhl 1820) (ZRC.2.5492).- One specimen was collected on a rock approximately 1 m above ground while basking along the trail to the top of the island. A juvenile was found at 1704 h on the ground beneath a piece of wood.

Varanus salvator (Laurenti 1768).- Fragments of shed skin were found in a coconut plantation behind the village.

Squamata (snakes):

Ramphotyphlops braminus (Daudin1803) (LSUPC. 4749).- One specimen was found within a rotting log next to a rock cave. A great deal of leaf litter and debris were present next to the log.

The reptiles and amphibians of Pulau Dayang are a subset of those found on Pulau Aur. We expect to find *Limnonectes blythii, Bronchocela cristatella, Cosymbotus platyurus, Cyrtodactylus consobrinus, Lygosoma*

WOOD, P. L., T. M. YOUMANS, C. RAYNOR, J. M. BERNARD, N. HINOJOSA, T. DYER, S. ANDREIKO, P. P. VAN DIJK, W. WUERTZ & L. S. YEEN. 2003. First report on the herpetofauna of Pulau Dayang, Pahang, West Malaysia. *Hamadryad* 27(2): 285-286.

YOUMANS, T. M., R. A. ESCOBAR, III, J. L. GRISMER, L. L. GRISMER & R. JOHNSON. 2002. First report on herpetofauna of Pulau Pemanggil. *Hamadryad* 27(1): 148-149.

Perry L. Wood, Thomas R. Szutz, Timothy M. Youmans & Jesse L. Grismer
Department of Biology, La Sierra University, Riverside, California 92515-8247, U.S.A.
Email: Perrwood@lasierra.edu, tomszutz@hotmail.com

Received: 4 July 2003.
Accepted: 25 July 2003.

Hamadryad Vol. 27, No. 2, pp. 284 – 285, 2003

First report on the herpetofauna of Pulau Dayang, Pahang, West Malaysia

Pulau Dayang is a small oblong-shaped island (1.9 x 3.8 km) located ca. 0.08 km north of Pulau Aur in the south-eastern portion of the Seribuat Archipelago at the southern end of the South China Sea. The island consists of a low range of granitic rock outcroppings with an elevated middle section being composed a giant boulder forming a peak. The majority of the island is covered with coastal vegetation which has been severely degraded. Small streams occur on the northern end of the island.

The herpetofauna of the adjacent island of Aur is known to have one frog, 14 lizards, and 4 snakes (Grismer et al, 2001; Escobar et al., 2003) but no field investigations have taken place on Pulau Dayang. Therefore, a herpetological survey was conducted with the intent of composing a preliminary checklist of the species diversity and to obtain tissue samples for DNA of representative specimens. A total of five lizards and one snake were collected.

Collections were made between 1200 and 1700 h on 22 July 2002 on the southern portion and summit of the island. Liver tissue and tail tips were taken from representative specimens and preserved in 90% ethanol. Specimens were preserved using 10% formalin and stored in 70% ethanol. Specimens collected are listed below. Museum acronyms are ZRC, The Zoological Reference Collection, at the Raffles Museum of Biodiversity Research, National University of Singapore and LSUPC, La Sierra University Photographic Collection at the Department of Biology, La Sierra University, Riverside, California.

Squamata (lizards):

Cnemaspis sp. (Das & Grismer 2003) (LSUPC.L7229).- One specimen was found on a rock under human trash, leaves, and pieces of wood at approximately 1650 h. This species was thought to be endemic to the adjacent Pulau Aur.

Hemidactylus frenatus (Duméril & Bibron 1836) (ZRC.2.5491).- Several individuals were seen in human habitations. One specimen was collected on the same rock as the *Cnemaspis* sp..

Gekko monarchus (Duméril & Bibron 1836) (ZRC.25493).- Two specimens were caught on the same rock as the *H. frenatus* and *Cnemaspis* sp. at approximately 1655 h under debris.

Mabuya mutifasciata (Kuhl 1820) (ZRC.2.5492).- One specimen was collected on a rock approximately 1 m above ground while basking along the trail to the top of the island. A juvenile was found at 1704 h on the ground beneath a piece of wood.

Varanus salvator (Laurenti 1768).- Fragments of shed skin were found in a coconut plantation behind the village.

Squamata (snakes):

Ramphotyphlops braminus (Daudin1803) (LSUPC. 4749).- One specimen was found within a rotting log next to a rock cave. A great deal of leaf litter and debris were present next to the log.

The reptiles and amphibians of Pulau Dayang are a subset of those found on Pulau Aur. We expect to find *Limnonectes blythii, Bronchocela cristatella, Cosymbotus platyurus, Cyrtodactylus consobrinus, Lygosoma*

bowringii, Sphenomorphus scotophilus, Calamaria lovii, Macrophistodon flaviceps, Ahaetulla prasina and *Emoia atrocostata* on Pulau Dayang, because these species occur on Pulau Aur (Grismer et al., 2001) and the islands are so close and the habitats are so similar. We do not expect to find *Acanthosaura armata* or *Dasia olivacea* owing to the severe deforestation. Future fieldwork is planned.

We are most grateful to Mr. Sahir bin Othman of the Department of Wildlife, Jabatan Perlindungan Hidupan Liar dan Taman Negara (PERHILITAN) for permission to conduct fieldwork in the Seribuat Archipelago. For comments on the manuscript we would like to thank L. Grismer. This research was conducted as part of a field biology course Biology 487F: Tropical Field Biology taught by L. Lee Grismer, H. Kaiser, J. A. McGuire and Jesse L. Grismer at La Sierra University Riverside, California, USA.

LITERATURE CITED

GRISMER, L. L, N. S. YAAKOB, B.-L. LIM, T.-M. LEONG, I. DAS, R. A. SOSA, J. L GRISMER, K. M. CRANE, R. E. DIAZ, S. V. FIGUEROA, C. A. LEDBETTER, S. C. NEWBOLD, S. R. NEWBOLD, C. P. PATEL, J. CASTRO, R. A. ESCOBAR, III, S. GUERRERO, J. W. PINEDO, J. D. TRUJILLO & H. KAISER. 2001. First report on the herpetofauna of Pulau Aur, Johor, West Malaysia. *Hamadryad* 26(2): 350-353.

ESCOBAR, R. A., III, J. CASTRO, D. MORGAN, S. M. HOVER, T. R. SZUTZ, K. McCLOSKEY & R. GREGORY. 2003a. Additions to the herpetofauna of Pulau Aur, Johor, West Malaysia. *Hamadryad* 27(2): 287-288.

Perry L. Wood, Tim M. Youmans, C. Raynor, J. M. Bernard, N. Hinojosa, T. Dyer, S. Andreiko, Peter Paul van Dijk, W. Wuertz and L. S. Yeen,
Department of Biology, La Sierra University, Riverside, California 92515-8247, U.S.A.
Email: Perrwood@lasierra.edu, timoyoum@lasierra.edu.

Received: 6 October 2002.
Accepted: 10 December 2002.

Hamadryad Vol. 27, No. 2, pp. 285 – 286, 2003

A record of *Anomochilus leonardi* Smith, 1940 (Anomochilidae) from Peninsular Malaysia

(with one text-figure)

The genus *Anomochilus* (family Anomochilidae) contains two species, *A. leonardi* Smith, 1940 and *A. weberi* (van Lidth de Jeude, 1890), and is distributed over Peninsular Malaysia, Borneo and Sumatra (Cundall et al., 1993). These fossorial snakes are rarely encountered, and thus little is known of their natural history. The holotype and paratypes of *A. leonardi* were collected in Pahang, at elevations between 230-240 m. a.s.l. (Smith, 1940). Lim and Mohd Sharef (1975) recorded the third specimen for Peninsular Malaysia from Gombak, Selangor, at about 200 m a.s.l. elevation. The discovery of *Anomochilus leonardi* by Stuebing and Goh (1993) extended the distribution of this species to Sabah, East Malaysia. The specimen from Sabah was collected under grassy herbaceous layer at the edge of forest, at about 20 m a.s.l. Another specimen was collected from Merapoh, Pahang and now kept at the wet collection of the Department of Wildlife and National Parks (DWNP), Kuala Lumpur (Lim Boo Liat, pers. comm.). The

FIGURE 1: *Anomochilus leonardi* from the campus of the Forest Research Institute Malaysia, Kepong (03º 14´N, 101º 38´E; 70 m a.s.l.), Selangor State, Malaysia (FRIM 0026).

bowringii, Sphenomorphus scotophilus, Calamaria lovii, Macrophistodon flaviceps, Ahaetulla prasina and *Emoia atrocostata* on Pulau Dayang, because these species occur on Pulau Aur (Grismer et al., 2001) and the islands are so close and the habitats are so similar. We do not expect to find *Acanthosaura armata* or *Dasia olivacea* owing to the severe deforestation. Future fieldwork is planned.

We are most grateful to Mr. Sahir bin Othman of the Department of Wildlife, Jabatan Perlindungan Hidupan Liar dan Taman Negara (PERHILITAN) for permission to conduct fieldwork in the Seribuat Archipelago. For comments on the manuscript we would like to thank L. Grismer. This research was conducted as part of a field biology course Biology 487F: Tropical Field Biology taught by L. Lee Grismer, H. Kaiser, J. A. McGuire and Jesse L. Grismer at La Sierra University Riverside, California, USA.

LITERATURE CITED

GRISMER, L. L, N. S. YAAKOB, B.-L. LIM, T.-M. LEONG, I. DAS, R. A. SOSA, J. L GRISMER, K. M. CRANE, R. E. DIAZ, S. V. FIGUEROA, C. A. LEDBETTER, S. C. NEWBOLD, S. R. NEWBOLD, C. P. PATEL, J. CASTRO, R. A. ESCOBAR, III, S. GUERRERO, J. W. PINEDO, J. D. TRUJILLO & H. KAISER. 2001. First report on the herpetofauna of Pulau Aur, Johor, West Malaysia. *Hamadryad* 26(2): 350-353.

ESCOBAR, R. A., III, J. CASTRO, D. MORGAN, S. M. HOVER, T. R. SZUTZ, K. McCLOSKEY & R. GREGORY. 2003a. Additions to the herpetofauna of Pulau Aur, Johor, West Malaysia. *Hamadryad* 27(2): 287-288.

Perry L. Wood, Tim M. Youmans, C. Raynor, J. M. Bernard, N. Hinojosa, T. Dyer, S. Andreiko, Peter Paul van Dijk, W. Wuertz and L. S. Yeen,
Department of Biology, La Sierra University, Riverside, California 92515-8247, U.S.A.
Email: Perrwood@lasierra.edu, timoyoum@lasierra.edu.

Received: 6 October 2002.
Accepted: 10 December 2002.

Hamadryad Vol. 27, No. 2, pp. 285 – 286, 2003

A record of *Anomochilus leonardi* Smith, 1940 (Anomochilidae) from Peninsular Malaysia

(with one text-figure)

The genus *Anomochilus* (family Anomochilidae) contains two species, *A. leonardi* Smith, 1940 and *A. weberi* (van Lidth de Jeude, 1890), and is distributed over Peninsular Malaysia, Borneo and Sumatra (Cundall et al., 1993). These fossorial snakes are rarely encountered, and thus little is known of their natural history. The holotype and paratypes of *A. leonardi* were collected in Pahang, at elevations between 230-240 m. a.s.l. (Smith, 1940). Lim and Mohd Sharef (1975) recorded the third specimen for Peninsular Malaysia from Gombak, Selangor, at about 200 m a.s.l. elevation. The discovery of *Anomochilus leonardi* by Stuebing and Goh (1993) extended the distribution of this species to Sabah, East Malaysia. The specimen from Sabah was collected under grassy herbaceous layer at the edge of forest, at about 20 m a.s.l. Another specimen was collected from Merapoh, Pahang and now kept at the wet collection of the Department of Wildlife and National Parks (DWNP), Kuala Lumpur (Lim Boo Liat, pers. comm.). The

FIGURE 1: *Anomochilus leonardi* from the campus of the Forest Research Institute Malaysia, Kepong (03º 14´N, 101º 38´E; 70 m a.s.l.), Selangor State, Malaysia (FRIM 0026).

record of this specimen though unpublished should be considered the third specimen from Pahang and fourth from Peninsular Malaysia.

The fifth specimen of *Anomochilus leonardi* from Peninsular Malaysia was found on 6 June 2002, on the balcony of a two-storied house, about 3 m of the ground, located within the campus of the Forest Research Institute Malaysia, Kepong (03º 14´N, 101º 38´E; 70 m a.s.l.), Selangor State. It was found dead next to a flowerpot, and is most likely to have been dead for few hours as numerous black ants and one millipede were already on it. Given its location and position, it is suspected that a bird may have accidentally dropped the snake. The specimen was preserved in 70% alcohol and deposited at the FRIM wet collection (FRIM 0026).

According to the data compiled by David and Vogel (1996: 36), the two specimens known from Sumatra were found in mountainous regions. In Peninsular Malaysia, all five specimens were collected below 250 m a.s.l.

Description.- Head not distinct from neck, smaller than tail; snout blunt; eye minute; tail short and blunt; rostral long, more than twice as long as broad, separating nasals and in contact with prefrontal; no separate loreal; one prefrontal and one large frontal; one preocular, one postocular and one supraocular; preocular in contact dorsally with prefrontal and frontal; four supralabials and five infralabials, the third touching eye; anal scale divided; dorsal scales smooth, not much larger than ventrals; midbody scales in 17 rows, ventral scales 229, and subcaudal 6. Snout-to-vent length 251 mm, tail length 6 mm.

Body colour uniformly glossy black, oval yellow spots on dorsum; these yellow spots bigan about 7 mm from snout, the last spot about 8 mm from tail tip, a yellow bar cover most frontal and part of preoculars; a red patch subcaudally.

LITERATURE CITED

CUNDALL, D., V. WALLACH & D. A. ROSSMAN. 1993. The systematic relationships of the snake genus *Anomochilus*. *Zool. J. Linnean Soc*. 109: 275-299.

DAVID, P. & G. VOGEL. 1996. The snakes of Sumatra. An annotated checklist and key with natural history notes. Editions Chimaira, Frankfurt-am-Main. 260 pp.

LIM, B.-L. & K. MOHD SHAREF. 1975. Notes on new locality records of some rare snakes from Peninsular Malaysia. *Malayan nat. J*. 29: 23- 27.

SMITH, M. A. 1940. A new snake of the genus *Anomochilus* from the Malay Peninsula. *Ann. & Mag. nat. Hist.* Ser. 11 6(35): 447-449.

STUEBING, R. B. & R. GOH. 1993. A new record of Leonard's pipe snake, *Anomochilus leonardi* Smith (Serpentes: Uropeltidae: Cylindrophinae) from Sabah, northwestern Borneo. *Raffles Bull. Zool*. 42(2): 311-314.

Norsham Suhaina Yaakob
Forest Research Institute Malaysia (FRIM)
52109 Kepong, Kuala Lumpur, Malaysia.
Email: norsham_yaakob@yahoo.com

Received: 12 March 2003.
Accepted: 11 April, 2003.

Hamadryad Vol. 27, No. 2, pp. 286 – 287, 2003

New Records of *Tylototriton verrucosus* Anderson, 1871 from Bhutan

(with one text-figure)

Tylototriton verrucosus is known from Nepal, east to north-eastern India, southern China, to Myanmar and northern Thailand (Dutta, 1997; Frost, 1985). It was previously reported from Bhutan, without further information (Frost, 1985).

On 11 July 2002, a specimen of *Tylototriton verrucosus* was collected from Thinleygang, a distance of ca. 50 km from Thimphu and ca. 20 km from Lobesa, Thimpu District, Bhutan, at a altitude of 1,600 m. The specimen was found crossing the road on a hot and humid day. The adjacent vegetation is cool broad-leaved evergreen oak forest, dominated by *Quercus lamelosa, Q. glouca, Castanopsis hystrix, C. tribuloides,*

record of this specimen though unpublished should be considered the third specimen from Pahang and fourth from Peninsular Malaysia.

The fifth specimen of *Anomochilus leonardi* from Peninsular Malaysia was found on 6 June 2002, on the balcony of a two-storied house, about 3 m of the ground, located within the campus of the Forest Research Institute Malaysia, Kepong (03º 14´N, 101º 38´E; 70 m a.s.l.), Selangor State. It was found dead next to a flowerpot, and is most likely to have been dead for few hours as numerous black ants and one millipede were already on it. Given its location and position, it is suspected that a bird may have accidentally dropped the snake. The specimen was preserved in 70% alcohol and deposited at the FRIM wet collection (FRIM 0026).

According to the data compiled by David and Vogel (1996: 36), the two specimens known from Sumatra were found in mountainous regions. In Peninsular Malaysia, all five specimens were collected below 250 m a.s.l.

Description.- Head not distinct from neck, smaller than tail; snout blunt; eye minute; tail short and blunt; rostral long, more than twice as long as broad, separating nasals and in contact with prefrontal; no separate loreal; one prefrontal and one large frontal; one preocular, one postocular and one supraocular; preocular in contact dorsally with prefrontal and frontal; four supralabials and five infralabials, the third touching eye; anal scale divided; dorsal scales smooth, not much larger than ventrals; midbody scales in 17 rows, ventral scales 229, and subcaudal 6. Snout-to-vent length 251 mm, tail length 6 mm.

Body colour uniformly glossy black, oval yellow spots on dorsum; these yellow spots bigan about 7 mm from snout, the last spot about 8 mm from tail tip, a yellow bar cover most frontal and part of preoculars; a red patch subcaudally.

LITERATURE CITED

CUNDALL, D., V. WALLACH & D. A. ROSSMAN. 1993. The systematic relationships of the snake genus *Anomochilus*. *Zool. J. Linnean Soc*. 109: 275-299.

DAVID, P. & G. VOGEL. 1996. The snakes of Sumatra. An annotated checklist and key with natural history notes. Editions Chimaira, Frankfurt-am-Main. 260 pp.

LIM, B.-L. & K. MOHD SHAREF. 1975. Notes on new locality records of some rare snakes from Peninsular Malaysia. *Malayan nat. J*. 29: 23- 27.

SMITH, M. A. 1940. A new snake of the genus *Anomochilus* from the Malay Peninsula. *Ann. & Mag. nat. Hist.* Ser. 11 6(35): 447-449.

STUEBING, R. B. & R. GOH. 1993. A new record of Leonard's pipe snake, *Anomochilus leonardi* Smith (Serpentes: Uropeltidae: Cylindrophinae) from Sabah, northwestern Borneo. *Raffles Bull. Zool*. 42(2): 311-314.

Norsham Suhaina Yaakob
Forest Research Institute Malaysia (FRIM)
52109 Kepong, Kuala Lumpur, Malaysia.
Email: norsham_yaakob@yahoo.com

Received: 12 March 2003.
Accepted: 11 April, 2003.

Hamadryad Vol. 27, No. 2, pp. 286 – 287, 2003

New Records of *Tylototriton verrucosus* Anderson, 1871 from Bhutan

(with one text-figure)

Tylototriton verrucosus is known from Nepal, east to north-eastern India, southern China, to Myanmar and northern Thailand (Dutta, 1997; Frost, 1985). It was previously reported from Bhutan, without further information (Frost, 1985).

On 11 July 2002, a specimen of *Tylototriton verrucosus* was collected from Thinleygang, a distance of ca. 50 km from Thimphu and ca. 20 km from Lobesa, Thimpu District, Bhutan, at a altitude of 1,600 m. The specimen was found crossing the road on a hot and humid day. The adjacent vegetation is cool broad-leaved evergreen oak forest, dominated by *Quercus lamelosa, Q. glouca, Castanopsis hystrix, C. tribuloides,*

FIGURE 1: *Tylototriton verrucosus*, collected on 11 July 2003, from Thinleygang, a distance of ca. 50 km from Thimphu (preserved in the Natural Resource Training Institute, Lobesa, Bhutan).

Ulnus nepalensis, Betula ulnoides and *Michaelia doltshopa*. There were paddy fields in the vicinity. The specimen was uniformly dark brown in colour. Measurements: snout-vent length 56 mm; tail length 58 mm.

A second specimen was found in a mud puddle on the roadside, at the same locality. It measured 75 mm in snout-vent length and 5 mm tail length.

Both specimens are preserved in the museum of the Natural Resource Training Institute, Lobesa.

I'd like to thank Thuji Sonam of Punakha for collecting the second specimen.

LITERATURE CITED

DUTTA, S. K. 1997. Amphibians of India and Sri Lanka (checklist and bibliography). Odyssey Publishing House, Bhubaneswar. (4) + xiii + 342 + xxii pp.

FROST, D. R. 1985. Amphibian species of the world. A taxonomic and geographical reference. Allen Press, Inc., and Association of Systematics Collections, Lawrence. (iv) + v + 732 pp.

Jigme Palden, Faculty of Forestry Sector, Natural Resources Training Institute, Lobesa, Bhutan. Email: jimipalden@hotmail.com

Received: 15 October 2002.
Accepted: 28 March 2003.

Hamadryad Vol. 27, No. 2, pp. 287 – 288, 2003

Additions to the herpetofauna of Pulau Aur, Johor, West Malaysia

The herpetofauna of Pulau Aur was first reported on by Grismer et al. (2001), which listed 19 species, comprising one frog, 14 lizards and four snakes.

We visited the island between 22–23 July 2002, with the purpose of further sampling the herpetofauna with the expectations of finding a species of *Draco*. To the report of Grismer et al. (2001), we add three species of lizards and provide voucher specimens of two previously unconfirmed species of lizards.

Collections were made during the afternoon and evening of 22 July 2002 and morning of 23 July 2002 in the vicinity of Teluk Bakau on the north-western side, and on the east side of the island at Teluk Ran. Specimens were collected by hand and blowpipe while searching through leaf litter, caves and trees, within primary and disturbed forests.

Abbreviations include:

Photographic collection, Department of Biology, La Sierra University, Riverside, U.S.A. (LSUPC)

Raffles Museum of Biodiversity Research, National University of Singapore, Singapore (ZRC)

Species observed on Pulau Aur that were not reported by Grismer et al. (2001) include the following:

Acanthosaura armata (Hardwicke & Gray, 1827) (ZRC 2.5490).- Two specimens were observed during the day, 1.5 m above ground level (agl) on small trees (0.5 and 10 cm diameter) in primary forest on the side of a hill, ca. 1 km behind Teluk Ran. The colour pattern of these specimens were more faded than those from Pulau Tioman.

Emoia atrocostata (Lesson, 1830) (ZRC 2.5488).- Grismer et al. (2001) provided an unconfirmed sighting of this species from Teluk Ran. A single specimen was collected during the day on rocks along the coast of the east side of the island at Teluk Ran.

FIGURE 1: *Tylototriton verrucosus*, collected on 11 July 2003, from Thinleygang, a distance of ca. 50 km from Thimphu (preserved in the Natural Resource Training Institute, Lobesa, Bhutan).

Ulnus nepalensis, Betula ulnoides and *Michaelia doltshopa*. There were paddy fields in the vicinity. The specimen was uniformly dark brown in colour. Measurements: snout-vent length 56 mm; tail length 58 mm.

A second specimen was found in a mud puddle on the roadside, at the same locality. It measured 75 mm in snout-vent length and 5 mm tail length.

Both specimens are preserved in the museum of the Natural Resource Training Institute, Lobesa.

I'd like to thank Thuji Sonam of Punakha for collecting the second specimen.

LITERATURE CITED

DUTTA, S. K. 1997. Amphibians of India and Sri Lanka (checklist and bibliography). Odyssey Publishing House, Bhubaneswar. (4) + xiii + 342 + xxii pp.

FROST, D. R. 1985. Amphibian species of the world. A taxonomic and geographical reference. Allen Press, Inc., and Association of Systematics Collections, Lawrence. (iv) + v + 732 pp.

Jigme Palden, Faculty of Forestry Sector, Natural Resources Training Institute, Lobesa, Bhutan. Email: jimipalden@hotmail.com

Received: 15 October 2002.
Accepted: 28 March 2003.

Hamadryad Vol. 27, No. 2, pp. 287 – 288, 2003

Additions to the herpetofauna of Pulau Aur, Johor, West Malaysia

The herpetofauna of Pulau Aur was first reported on by Grismer et al. (2001), which listed 19 species, comprising one frog, 14 lizards and four snakes.

We visited the island between 22–23 July 2002, with the purpose of further sampling the herpetofauna with the expectations of finding a species of *Draco*. To the report of Grismer et al. (2001), we add three species of lizards and provide voucher specimens of two previously unconfirmed species of lizards.

Collections were made during the afternoon and evening of 22 July 2002 and morning of 23 July 2002 in the vicinity of Teluk Bakau on the north-western side, and on the east side of the island at Teluk Ran. Specimens were collected by hand and blowpipe while searching through leaf litter, caves and trees, within primary and disturbed forests.

Abbreviations include:

Photographic collection, Department of Biology, La Sierra University, Riverside, U.S.A. (LSUPC)

Raffles Museum of Biodiversity Research, National University of Singapore, Singapore (ZRC)

Species observed on Pulau Aur that were not reported by Grismer et al. (2001) include the following:

Acanthosaura armata (Hardwicke & Gray, 1827) (ZRC 2.5490).- Two specimens were observed during the day, 1.5 m above ground level (agl) on small trees (0.5 and 10 cm diameter) in primary forest on the side of a hill, ca. 1 km behind Teluk Ran. The colour pattern of these specimens were more faded than those from Pulau Tioman.

Emoia atrocostata (Lesson, 1830) (ZRC 2.5488).- Grismer et al. (2001) provided an unconfirmed sighting of this species from Teluk Ran. A single specimen was collected during the day on rocks along the coast of the east side of the island at Teluk Ran.

Lipinia surda (Boulenger, 1902) (LSUPC-L7575-83).- A single specimen was collected in disturbed habitat under a fallen palm frond in the village of Teluk Bakau. This specimen constitutes the first record of this species from Pulau Aur.

Lipinia vittigera (Boulenger, 1894).- A single specimen was observed ca. 5 m agl on the same tree (0.5 m diameter) where *Acanthosaura armata* was collected. The specimen was not collected or photographed, and therefore the species remains to be confirmed for the island.

Sphenomorphus scotophilus (Boulenger, 1900) (ZRC 2.5489).- Grismer et al. (2001) provided an unconfirmed sighting of this species from Teluk Ran. Several individuals were observed on boulders in disturbed habitat in the villages at Teluk Bakau and within the forest at Teluk Ran.

Although villagers have reported the presence of a "flying" lizard, perhaps *Draco* or *Ptychozoon* (see Grismer et al., 2001), its presence on Pulau Aur remains unconfirmed, despite the efforts made by searching at higher elevation primary forest. However, the presence of the diurnal agamid *Acanthosaura armata* reassures us that there is sufficient comparable habitat to support other diurnal agamids, such as *Draco* and *Aphaniotis*, and possibly gliding geckos of the genera *Ptychozoon* and *Cosymbotus.* More field work is planned for this island.

This research was conducted as part of a field biology course Biology 487F: Tropical Field Biology taught by L. Lee Grismer, J. L. Grismer, H. Kaiser and J. A. McGuire at La Sierra University. We would like to thank Sahir bin Othman, Director of Research and Conservation Division, PERHILITAN, for permission to conduct field work in the Seribuat Archipelago, and Peter Kee Lin Ng, Chang Man Yang and Kelvin Kok Peng Lim for permitting us to examine material under their care. Special thanks are due to our friends Tomothy M. Youmans, Jesse L. Grismer, Perry L. Wood, Seth D. Kendall and the students of the field biology course Biology 487F at La Sierra University for their field assistance.

LITERATURE CITED

GRISMER, L. L., N. S. YAAKOB, B.-L. LIM, T.-M. LEONG, I. DAS, R. A. SOSA, J. L. GRISMER, K. M. CRANE, R. E. DIAZ, S. V. FIGUEROA, C. A. LEDBETTER, S. C. NEWBOLD, S. R. NEWBOLD, C. P. PATEL, J. CASTRO, R. A. ESCOBAR, III, S. GUERRERO, J. W. PINEDO, P. A. JONES & H. KAISER. 2001. First report on the herpetofauna of Pulau Aur, Johor, West Malaysia. *Hamadryad* 26(2): 350-353.

Ricardo A. Escobar, III[1], J. Castro, D. Morgan, S. M. Hover, Thomas R. Szutz, K. McCloskey and R. Gregory.
Department of Biology, La Sierra University, Riverside, California 92515-8247, U.S.A.
[1]Email: ricaesco@hotmail.com

Received: 15 October 2002.
Accepted: 4 February 2003.

A PHOTOGRAPHIC GUIDE TO THE SNAKES AND OTHER REPTILES OF INDIA
by Indraneil Das, 2002.
New Holland Publishers (UK) Ltd., London. 144 pp. ISBN 1 84330 125 3.
Softcover. 19 x 9.5 cm. Available from New Holland Publishers (UK) Ltd., London, Garfield House, 86-88 Edgware Road, London W2 2EA, United Kingdom.
Email: alex@nhpub.co.uk.
Price: £ 7.99.

This excellent little photographic guide covers a whopping 243 species of Indian snakes, lizards, crocs and turtles/tortoises. The general format is a colour plate and short description of each species covering half a page. Each family of reptiles has an introductory paragraph that summarizes the main features of the group which, along with the mostly exceptional photos makes the book a good field guide. There are eight pages of introduction, map, notes about the book, a bit on reptile habitats, a page on conservation and a page on snakebite. Everything is kept concise with no frills which works well for this kind of photo guide book.

The book does contain some bloopers and typos. Here are some of them: In the Introduction, Neil tells us that "while in cobras and kraits, the venom trickles down grooves into the prey body." I can see how this myth is perpetrated; if you look at a highly magnified picture of a cobra fang it does indeed seem to have a groove down the front, but this is in fact the point where the developing fang folds together to form the hollow venom "tube" through the length of the fang. Under "Reptile habitats in India" the land area of India is given as 297,000 ha when it's well over 3,000,000 sq. km! The Western Ghats has hills approaching 2700 m high (not just a mere 1500 m) and rainfall often exceeds 5000 mm (well over the 2000 mm mentioned in the book.) The species descriptions with notes on their biology are short but adequate. The extralimital ranges make this book useful in South Asia in general. Disregard the typo that the Common Vine Snake is only 3 cm at birth, it's more like 20 cm. A fellow reader shared my chuckles about MacClelland's Coral Snake, "that advertises its deadly bite, from the hills of north-eastern India!" Another nit-pick is the size of the gharial at birth: not 17-18 cm but 30 cm.

I have a slight problem with the arrangement of the snake families in alphabetical order rather than "evolutionary" order, the way M. A. Smith arranges them in his 'Fauna of British India,' Vol. III. For one thing, the Blind Snakes and Uropeltidae (primitive, burrowing snakes) appear next to Viperidae rather than at the beginning, before the Boidae. We're so used to the Smithian order that Neil's is a bit jarring.

But as a self-described "ideal pocket-size traveling companion" for any naturalist living in or visiting India, this is an essential buy. The book is an important step toward popularizing, understanding and appreciating the remarkable (but little studied) reptiles we have in India.

Rom Whitaker, Centre for Herpetology,
Madras Crocodile Bank Trust, Post Bag 4,
Mamallapuram, Tamil Nadu 603 104, India.
Email: draco@vsnl.com

TRUE VIPERS– NATURAL HISTORY AND TOXINOLOGY OF OLD WORLD VIPERS
by David Mallow, David Ludwig and Göran Nilson. 2003.
Krieger Publishing Company, Melbourne, Florida. 410 pp. ISBN 0-89464-877-2.
Hardcover. Available from: Krieger Publishing Company, P. O. Box 9542, Melbourne, Florida 32902-9542, U.S.A.
Email: marketing@krieger-pub.com.
Price: US $ 79.50.

Another welcome snake book from Krieger, "True Vipers" sounds like a movie title. Mallow, Ludwig and Nilson have obviously sifted through a mountain of literature to provide us with this very useful review and summary of all the Old World vipers. Besides finding some good tidbits (like the nasal sac with sensory function in some vipers– their answer to sensory pits), the reader now has, in one tome, a handle on this group of awesome snakes, covering literally half the world.

The Introduction provides a concise overview of the viperid venom systems, effects of venom and treatment. It was pleasing to see that Ewart's "Poisonous Snakes of India" 1878 was referred to (just once) but how about the venom experiments of Russell, Fayrer and Wall, early venom researchers and all classic stuff.

Other critical comments: the cover design and colour is insipid and the *Atheris* photo, sharp in the text, is soft. Not a single map in the book! American readers aside, even those with a good grasp of geography would love to see range maps and the region covered in the text. There is no index either, not as bad a crime as no maps (and, it is acknowledged that doing an index is a bloody pain) but it is mandatory for a reference book.

There are other glitches in the book (besides the occasional typo), for example *Echis carinatus* is said to average 60 cm in length; this may be true elsewhere but the central and south Indian and Sri Lankan forms average only 30 cm. Aside from desert areas in north-western India, *Echis* don't live on sand and rarely move by side winding. The statement that *Echis* bites result in more deaths than any other snakebite is not verifiable. It is unlikely to be true, considering that India is supposed to have the highest snakebite mortality in the world and the fact that *Echis* here account for a relatively small percentage of deaths (compared to *Daboia russelii*, *Naja* sp. and *Bungarus caeruleus*). Under 'Remarks', page 187, the authors state, "saw-scaled vipers have few natural enemies"! I could list a page full of minor enemies after the serious ones like bull frogs, skinks, ophiophagus snakes, an array of birds like the peacock and raptors, a heap of mammals like the mongooses, civets, etc.

When I worked for Bill Haast at the Miami Serpentarium, we used to introduce huge fanged snakes to the visitors with a tongue-in-cheek "with fangs like this, the Gaboon viper hardly needs venom!" I was surprised to read (with reference to the Levantine viper) that "this is a large snake with long fangs and the severity of the bite may be due as much to physical trauma as the chemical nature of the venom." Hello? A stab from a smooth, sharp fang is as bad as an injection of a toxic cocktail?

I'm not sure if colleagues more familiar with European and African vipers will have more to criticize but despite these problems here is one book you will refer to again and again. The species descriptions are complete with excellent bits of interest such as the snakebite case histories which tell you a lot more than the usual: "pain, swelling, bleeding and sometimes death." It would be real nice to see the relevant pictures with the species description but bunching the photo art paper pages is more economical for the publisher, I guess.

The Bibliography is itself an important reference work and the glossary is useful. Still miss that index though.

Rom Whitaker, Centre for Herpetology,
Madras Crocodile Bank Trust, Post Bag 4,
Mamallapuram, Tamil Nadu 603 104, India.
Email: draco@vsnl.com

THE CANE TOAD. THE HISTORY AND ECOLOGY OF A SUCCESSFUL COLONIST
by Christopher Lever.
2001. Westbury Academic and Scientific Publishing,
Otley. xxvii + 230 pp. ISBN 1 84103 006 6. Hardcover with dust jacket.
Available from: Westbury Academic and Scientific Publishing, Ilkey Road, Otley, West Yorkshire LS21 3JP, United Kingdom. Tel: 01943 467958; Fax: 01943 850057.
Price: £ 44.00.

Described as the most widely distributed terrestrial vertebrate in the Pacific and Caribbean regions, the cane or marine toad (*Bufo marinus*) is the sole subject of this substantial volume. My own introduction to the species happened one rainy night, a decade ago, in the paddy fields of Los Banõs, in the Philippines. I could find no other amphibians, but this! On a recent trip, I was therefore pleased to see cane toad leather coin purses on sale at a duty-free shop in Ninoy Aquino International Airport, Manila.

Christopher Lever is an authority on naturalised animals of the world, and has written works covering the introduced animals of the British Isles, on the naturalised mammals, birds and fishes of the world, the Mandarin Duck, and on several others topics. This is his maiden herpetological title, dealing with the amphibian world's equivalent of a cockroach. The source of the work not only includes published works, but also correspondence from a vast network of specialists and many other knowledgeable individuals (listed in the 'Acknowledgements', which, amusingly, also contains a long list of people who did not respond to the author's request for information!).

The work commences with a sentence from Zug and Zug (1979), "Marine toads have few admirers and are usually described as looking like mobile cow patties". Nonetheless, after sifting through the over 250 pages of text, one cannot but admire the persistence of these 'villains' of the herpetological world. For despite the often extreme measures taken for their eradication in some areas where they have been naturalised, humans have failed. Map 13 on p. 105 dramatically shows how some isolated founder populations (from Hawai'i), spread along the west coast of Queensland from 1939 to 1980 and Map 15 on p. 111 shows the current distribution of the species, which covers much of north-eastern Australia, including parts of the Northern Territory, Queensland and New South Wales.

The work is divided into a general introduction, a review of the natural history of the cane toad, a separate section on the status of naturalised populations of the species (from Japan, Philippines, Taiwan, Thailand, Egypt, the Chagos Archipelago, Mauritius, Bermuda, the southern states of the U.S.A., Central and South America, Australasia and Oceania), a chapter devoted to the impact of the species in Australia, and one on the biological control in the same island nation. The two last chapters deal with evolutionary experiments and on declining amphibian populations. This last chapter includes information on both the IUCN Declining Amphibian Populations Task Force, its origins and mission, as well as enumeration of characters of amphibians that render them perhaps more sensitive than other organisms to environmental change. About four pages of appendix provide details of introductions, including dates, sources and primary authorities. Interestingly, most introductions predate World War II; in Japan, one was as late as 1978. A glossary lists mostly biological terms (not really necessary in a work of this nature, in my personal opinion), and 30 pages of references, including virtually everything ever written on the cane toad. The volume concludes with two indices, the first on parasites, pathogens and diseases, the second, of names of animals and plants.

Cane toads have been described as ‘a hopping cocktail of cardio-active substances’ (p. 29) and much remains to be learnt of the toxic secretions of this and other species of bufonids. Lever remarks how the species is perceived in different parts of its range. In some, it is protected, in (many) others, it is treated as a pest of major proportions, and huge sums of money are spent annually to exterminate these introduced populations!

A wonderful summary of the biology of a remarkable animal!

Indraneil Das, Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300, Kota Samarahan, Sarawak, Malaysia.
Email: idas@ibec.unimas.my.

REVIEWERS FOR *HAMADRYAD*
Vol. 27 (1 & 2)

H. V. Andrews, D. Basu, A. M. Bauer, R. Bour, R. M. Brown, S. K. Chanda, P. David, K. Dodd, A. Dubois, S. K. Dutta, W. Erdelen, O. Ettore, J. G. Frazier, D. Gower, R. F. Inger, J. B. Iverson, T.-M. Leong, C. J. McCarthy, W. P. McCord, A. Ohler, H. Ota, N. Pilcher, J. P. Ross, B. Stuart, P. P. v. Dijk, V. Wallach, R. G. Webb, E. Wikramanayake, A. Wynn.

The contents of recent back issues of *Hamadryad* can be viewed at:
http://www.herplit.com/contents/hamadryad.html